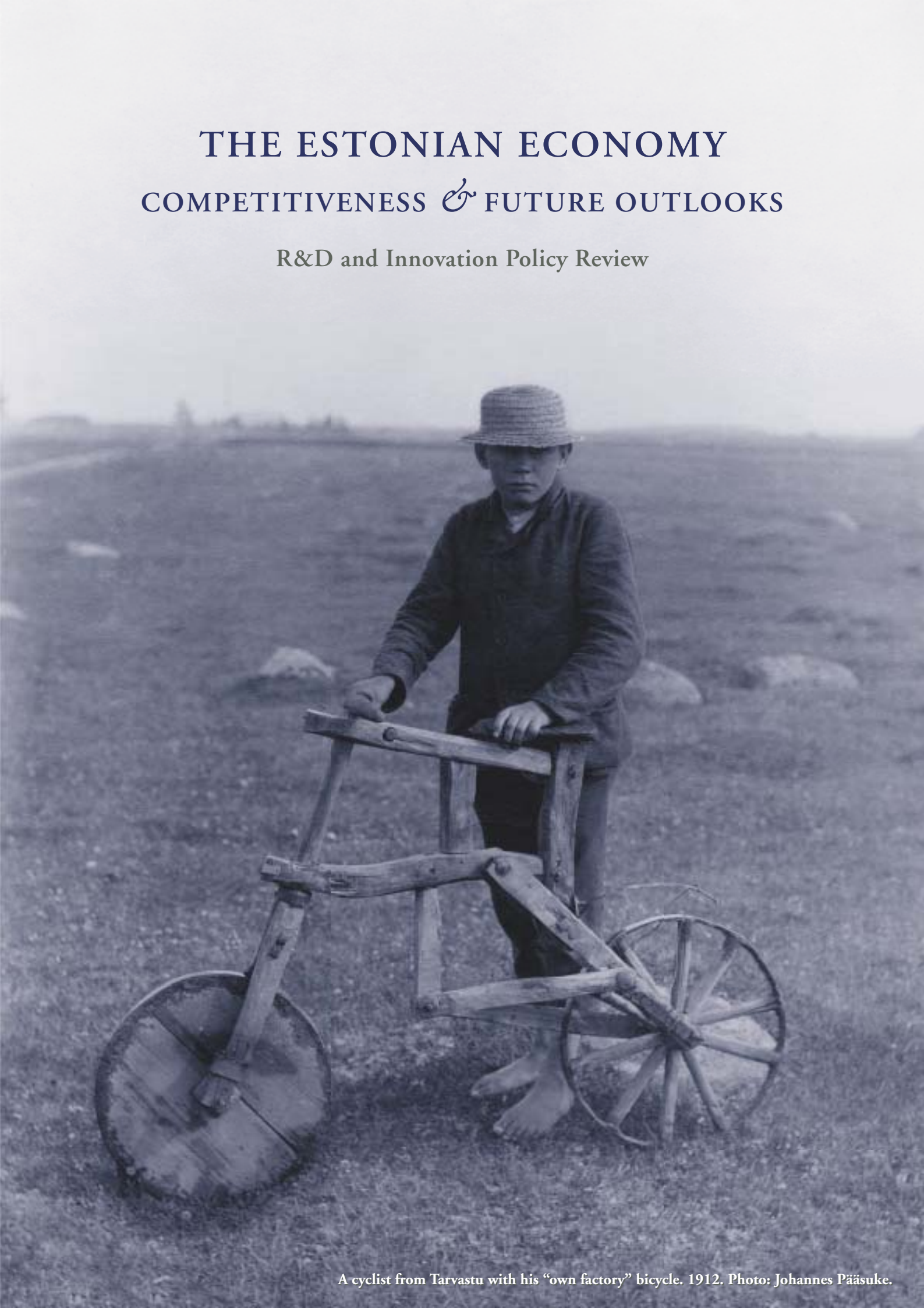
THE ESTONIAN ECONOMY

COMPETITIVENESS & FUTURE OUTLOOKS

R&D and Innovation Policy Review



A cyclist from Tarvastu with his "own factory" bicycle. 1912. Photo: Johannes Pääsuke.

Competitiveness and Future Outlooks of the Estonian Economy

R&D and Innovation Policy Review

Research and Development Council

Tallinn 2003

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Marek Tiits, Rainer Kattel, Tarmo Kalvet, Rein Kaarli

Research and Development Council, steered by Prime Minister Siim Kallas, approved this review on 28 November 2002. The review went through some editorial changes before print.

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Foreword

In the last few years lively discussions have been held in Estonia about what the country's hitherto economic growth has rested on and how to speed it up in order to catch up with the average living standard of the European Union.

Knowledge-based economy is increasingly the key term used in the discussions about the strategies of future economic development in Estonia, Europe, Asia as well as in America. The Estonian Research and Development Council, as strategic advisor to the Government, has substantial contributions to make in these discussions.

In general terms, the Regular Report on Estonia's progress towards accession to the European Union, as well as the World Economic Forum and several other organisations estimate Estonia's economic situation and its future perspectives to be promising in the global competitiveness setting, pointing out, however, a few dangers that need to get the Government's careful attention in the near future.

The current Review synthesises the results of various international surveys about Estonia. In their analysis the authors relied on widely accepted economic approaches. The Review aims to give a maximally objective and pragmatic view of the Estonian socio-economic conditions and foundations of development. The issues related to specific aspects of research policy, which are traditionally the main concern of the Research and Development Council, will only receive a cursory glance.

The terms innovation policy, economic policy, or public policies in general used in this report do not represent any particular political party's policies. The authors use them, proceeding from the classical public administration perspective, thus proposing a certain universal foundation that does not depend on the political leanings of the parties that form the Government or fill the seats in *Riigikogu* [Estonian parliament].

Contents

Executive summary

Current Review of research and development activities analyses the foundations of the hitherto economic growth in Estonia and relates these to the objectives of the strategy *Knowledge-based Estonia*. Compared to the previous research and development studies this analysis pays more attention to the economy, its competitiveness, innovativeness and demand for research and development.

The Review relies on various international surveys that have analysed the competitiveness of Estonian economy, combines their conclusions into an integrated whole, and analyses the situation in the context of implementing the strategy *Knowledge-based Estonia*.

Estonian catch-up with the developed industrial countries in terms of welfare and economic growth during the 90's is associated with the application of new technology and knowledge imported from more developed countries. The last decade has witnessed economic growth that is based on technology transfer spurred by foreign direct investments that has increased the efficiency of the economy. As the economic environment has become more stable and opened up, the growth of the economy has seemed to be automatic.

Overall Estonia has enjoyed positive development. However the rapid increase of current account deficit and the faster rise of real income compared to the rise in productivity have become more serious problems that make it harder to hold the macroeconomic balance of economy. In order to avoid any major economic setbacks Estonia should be able to significantly expand the volume of its exports.

Then again the increase in export *per se* is of no importance. Exporting low priced products that only contribute enough to secure barely minimal wages is not enough to induce economic growth. Competitiveness is based on productivity. Only high productivity enables a country to maintain a strong currency and a high level of welfare. The real aim is increased productivity in creating quality goods that set the prices on world markets.

Every entrepreneur chooses whether his or her competitive advantage stems from a relatively lower cost base or from the ability to offer higher quality that permits to ask a higher price. The competitiveness of a nation in turn depends on how knowledge intensive are individual enterprises. The larger the number of entrepreneurs that rely on higher quality to gain their competitive advantage, the better the economy does overall.

In order to raise the competitiveness of the economy it is crucial to obtain the highest possible rise in productivity in the industrial sector as the technology driven rise in the productivity of agricultural and services sectors can only be much more limited. Returns to scale support efficiency gains in the manufacturing industry which in turn help to offset the smaller growth potential in other sectors and in so doing raise the productivity of the economy as a whole.

However, the analysis demonstrates that the importance of industries in middle- and high-level technology sectors in the creation of added value in Estonia is decreasing. Despite the enviable records of economic growth in Estonia the competitiveness of the industrial sector has significantly decreased over the 1990's.

The specialisation of the Estonian industry on labour and resource intensive fields indicates an imminent threat of a lock-in to a low income level. Compared to the industrial structures of Central and Eastern European countries Estonia's situation is poor and should the current specialisation continue - hopeless. With the current industrial structure Estonia will never catch up with the European Union in economic development.

Estonia wishes to catch up with the EU average standard of living as soon as possible but is quickly losing its competitive advantage that hitherto resulted from cheap labour and, to a lesser extent, from local raw

materials. In addition, the rise in exports is decreasing mainly due to quality issues. Estonia neither develops nor produces a sufficient amount of new high-quality goods and services.

The ability to create and use economically viable new products depends mainly on the level of education. In the framework of global free movement of capital the welfare of the developed countries relies on human resources. Therefore the economic growth of Estonia and other transition economies is in direct relation to their ability to raise the level of knowledge required in the competitive economy to the level of that of the countries with higher income, as well as on the ability to produce and implement strategically correct decisions.

In order to break out of the mould of cheap subcontractor, Estonia needs to have a comprehensive economic policy that is targeted at raising the effectiveness of technologies and organisations by introducing new knowledge and processes as well as substantially intensifying research and development according to the demands set by the economic development.

The general understanding of the strategy *Knowledge-based Estonia* (approved by *Riigikogu* on 6 December 2001) which is probably the most significant economic policy document produced in Estonia after regaining the independence, is still very poor in the society as a whole, including in the midst of politicians, entrepreneurs, public servants and scientists.

Increased funding on its own is not sufficient to properly implement *Knowledge-based Estonia*, but the funding must be channelled to the most prospective fields. A strategy for raising the competitiveness of the economy must be based on a vision that has strong support in the society and on a national development plan that stems from it. Neither is a declarative call to the youth to choose for the fields of science and technology sufficient. The state financing of higher education and graduate studies must be based on an analysis of the future demand for labour in the academic sector as well as in the whole society.

General upgrading of science infrastructure is of no help. This must be integrated into the elaboration of the necessary basis for the development of education and innovation. Neither does supporting single research and development projects *per se* create a significant amount of benefit. It is important to establish internationally renowned centres of excellence in science.

Drawing on the experiences of Finland, Ireland and the Asian Tigers the main pillars for raising the competitiveness of Estonian economy are:

– purposeful effort to attract knowledge and technology intensive foreign direct investments;
– specialising on the sectors that are perceived to induce the highest rate of growth (IT, bio- and nanotechnology), and using these technologies to raise the productivity of the traditional industries;
– significantly raising the effectiveness of educational system, investments into education, skill conversion and retraining on all levels.

1. Introduction

1.1 Objective of the review

The strategy *Knowledge-based Estonia* sees future Estonia as knowledge-based society in which scientific research directed at finding new knowledge, application of knowledge and skills, and developing human capital will have become the source of growth and competitiveness of the economy, labour, and the quality of life.[1]

Before the Barcelona Summit, Jose Maria Aznar, President of the European Council, called on the candidate countries to participate actively in the 'Lisbon process' to make the European Union by the year 2010 the most competitive knowledge-based economy in the world. This message was further boosted by the decision adopted at the Barcelona Summit by the heads of state and government leaders of the Member States of the European Union to increase investments in research and development so that they would reach up to 3% of the respective countries' GDP by 2010.[2]

In order to provide new impetus for economic development, like in developed countries, 2/3 of the candidate countries investments into research and development, should come from the private sector. This is an extremely serious challenge for Estonia where in 2000 companies' investment in R&D was merely 0.15% of the GDP,[3] and exporting companies had on average 1.5 employees devoted to product development.[4]

The meaning and importance of these strategies for the future of Estonia extends far beyond the mere planning (or increasing the financing) of the research and development efforts carried out by universities and institutes. The messages forwarded to the candidate countries within the last year by the World Economic Forum, the World Bank, the Organisation of Economic Cooperation and Development, the European Investment Bank, the European Bank for Reconstruction and Development, the British Council and several other international organisations have once again confirmed that Estonia, having reached the final stage in its accession to the European Union, has to face these strategies very seriously.[5]

It appears from Figure 1 that in 2001 high domestic demand compensated for the weak status of exports in the EU candidate countries. At the same time, as characteristic of transition societies, foreign investment has supported the financing of the country's current account deficit. Success of candidate countries in getting ready for EU accession has sent impressive positive messages to the world about the region. This is probably one of the reasons why foreign investment in the candidate countries has not decreased in recent years despite the opposite general global trend. The IMF's warning that, due to their high current account deficit, the economies of Central and Eastern Europe are extremely vulnerable to a change of attitude among international investors should call for caution.[6] Estonia's situation may become even more complicated with the eventual decrease in the inflow of foreign direct investment (FDI) concurrent with the completion of privatisation.

1 *Knowledge-based Estonia, Estonian Research and Development Strategy 2002–2006*, Riigikogu, RTI 2001, 97, 606, 2001, http://www.tan.ee/tan/en/doc/Index/reviews/.

2 *Barcelona Summit*, 15-16 March 2002, http://europa.eu.int/comm/barcelona_council/index_en.html.

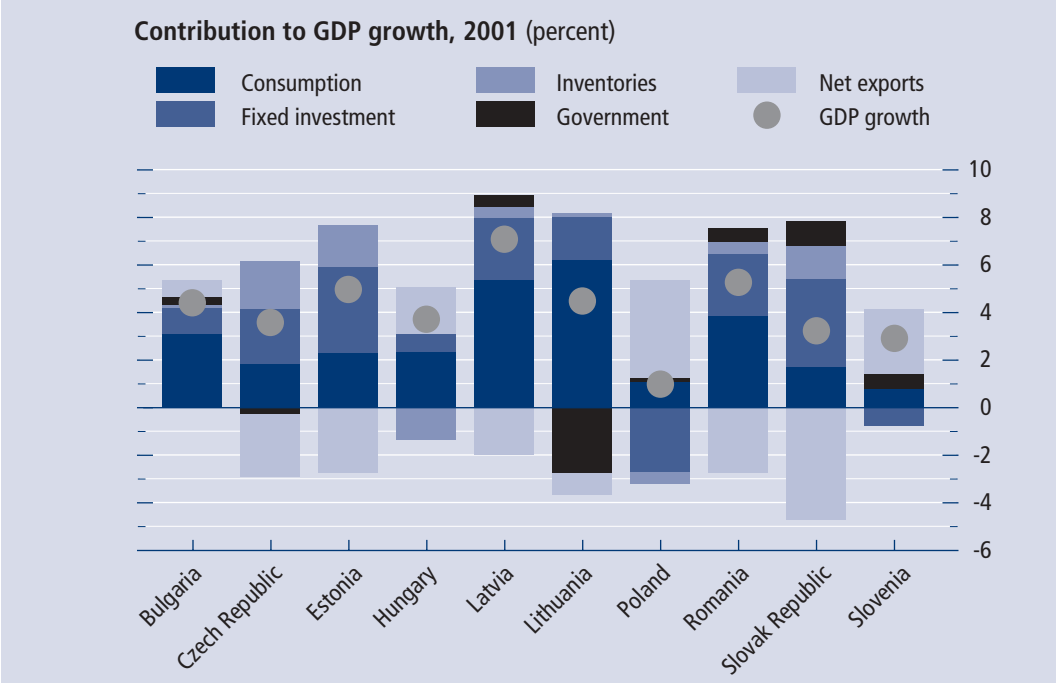
3 *Statistical Yearbook of Estonia 2002*, Statistical Office of Estonia, Tallinn 2002.
See also Figure 22, R&D expenditures by performing sector in some OECD countries and Estonia in 2000.

4 *Study of exporters 2001 (Eksportööride uuring 2001),* Estonian Trade Promotion Agency, Ariko Marketing, p. 5.

5 For example: *World Bank Knowledge Economy Forum*, http://www.worldbank.org/eca/kedforum/.

6 *World Economic Outlook*, International Monetary Fund, April 2002, pp 35-39.

Figure 1. **Economic growth of the EU candidate countries in 2001**



Source: *World Economic Outlook*, IMF, April 2002, http://www.imf.org/external/pubs/ft/weo/2002/01/.

If there had been no deterioration of Estonia's foreign trade balance due to the loan boom and rapid growth of domestic consumption, if there had been no general decline of the world economy and no decrease in global foreign direct investment flows, we might gracefully lay aside this issue as unimportant. Unfortunately, in reality all this happened, which more than ever before raises on top of the agenda the question about how to secure the macro-economic balance while retaining rapid economic growth.

The strategy *Knowledge-based Estonia* endorsed by the Government of the Republic and *Riigikogu* outlines the purpose and general principles of the activities; however, it does not provide a specific strategic action plan how to achieve the desired changes in society and economy. The creation of a knowledge-based economy and society and the preparation of respective action plans presuppose that the situation of the Estonian economy be analysed and deeper insights into the current basis of economic development gained. Only this basis can serve the planning of Estonia's future in a way that would guarantee rapid economic growth and harmonisation of the average wage level in Estonia with that of the European Union.

With this review, the Research and Development Council provides an account of the foundations of Estonia's rapid economic progress in the last ten years, its competitiveness and the likely prospects for the Government, the ministries responsible for policymaking in several areas, entrepreneurs, scientists and the general public.

1.2 Main directions of the review

Nobody doubts the importance and urgency of rapid economic growth for Estonia whose average wage is presently more than twice as low as the European average - this is the only way to make progress and find a solution to the current and future social and economic problems.

During the last year, we have increasingly been asking questions about the sources of Estonia's economic growth and about the factors that have ensured the last decade's success in Estonia. Answering these questions would in fact mean answering the question about how to maintain the rapid and vigorous pace of economic growth of the 1990s.

"How is economic growth created?" has been the central issue for any modern economist since the appearance of the first market economy-based society. No modern or earlier economy has grown at the same speed as the market economies of North America, Western Europe and Japan in recent centuries. The Soviet Union harnessed all of its natural and human resources in the service of its centrally planned economy; however, the living standard lagged far behind that of free market economies, and eventually the union collapsed due to its inability to provide for its citizens. Do we know today why capitalist economies are growing faster than others?

At different times different theories have fed competing ideologies and political movements.[7] However, the purpose of the present review is not to expand or develop this colourful and undoubtedly necessary discussion. We are interested in whether there is something that Estonia should do to ensure continued rapid economic growth. Looking for answers to this question, this review will deliberately avoid any ideological or short-lived political discussions, focusing on the development of economic theory within the last century.[8]

This paper, being a somewhat non-traditional review of research and development and innovation policy, takes as the starting point of its analysis the consensus expressed in one of the most important economic policy documents of Estonia since regaining independence, the document which was adopted by *Riigikogu* and the Government of the Republic in 2001 – the Estonian Research and Development Strategy *Knowledge-based Estonia 2002–2006*.

[7] Depending on the era, social and economic background of the person, etc., Adam Smith, David Ricardo, Karl Marx, Thorstein Veblen, John Stuart Mill, Thomas Robert Malthus, John Maynard Keynes, Joseph A. Schumpeter and many other developers of economic thought have over the recent centuries sought to describe the basis of growth of market-led economy, using different or even downright contradictory explanations.

[8] The starting point for the following analysis is the economic indicators which are listed as important factors at driving the economic development by the majority of modern economic theory approaches: neo-classical Solow-Swan model, models of endogenous and evolutionary economic growth. See, for example, Robert M. Solow "A Contribution to the Theory of Economic Growth", *Quarterly Journal of Economics*, 70 (1), 1956; Trevor W. Swan, "Economic Growth and Capital Accumulation", *Economic Record*, 32, 1956; Robert E. Lucas, "On the Mechanisms of Economic Development", *Journal of Monetary Economics*, 22 (July), 1988; Paul M. Romer, "Endogenous Technological Change", *Journal of Political Economy*, 98 (5), 1990; Richard R. Nelson, *National Innovation Systems: A Comparative Analysis*, New York and Oxford, Oxford University Press 1998; Christopher Freeman, *Technology and Economic Performance: Lessons from Japan, London*, Pinter 1987; Carlota Perez, *Technological Revolutions and Financial Capital. The Dynamics of Bubbles and Golden Ages*, Cheltenham - Northampton, MA: Edward Elgar Publishers, 2002.

The review analyses the sources of Estonian economic growth and relates them to the objectives of *Knowledge-based Estonia*, which are:

– to increase the share of R&D expenditures to 1.5% of the GDP by 2006,
– to promote co-operation between scientific research establishments and business;
– to increase substantially the share of R&D activity carried out within the private sector.

Most of the traditional indicators[9] do not allow assessment of the impact of research and development on economic development.[10] At the same time, without knowing the driving forces of economic development and not understanding what current sources influence economic development, it is impossible to plan adequately the actions necessary for implementation of the strategy *Knowledge-based Estonia*.

Therefore, unlike previous works, we pay more attention to the demand side of the research and development activity and innovation. Our objective is to create an appropriate framework that would measure the current state of development of the Estonian economy and provide an opportunity to assess the prerequisites for eventual future developments.

Our review will take a pragmatic approach to the economic success of developed industrial countries based upon the economic analyses made by the World Economic Forum,[11] the Organisation of Economic Cooperation and Development,[12] the European Union[13], the United Nations Industrial Development Organisation (UNIDO)[14] and others. We will also examine the development strategies of Ireland, Finland and other countries that have achieved rapid economic growth in the recent decades, and will scrutinise what errors and why were made by other countries in similar phases of development.

9 Fore example the number of scientists and engineers, research and development projects and publications, patent statistics, etc.; which are also presented in the Appendices of the current review.

10 A more thorough analysis is provided for example by Alister Scott, Grové Steyn, Aldo Geuna, Stefano Brusoni, Ed Steinmueller, *The Economic Returns to Basic Research and the Benefits of University-Industry Relationships, A literature review and update of findings,* Report for the Office of Science and Technology, Brighton, SPRU, University of Sussex, 2001, http://www.sussex.ac.uk/spru/publications/econreturnsost.pdf.

11 *World Economic Forum*, http://www.weforum.org.

12 *The new economy. Beyond the hype: Final Report on the OECD Growth Project*, OECD, Paris 2001, http://www.oecd.org/pdf/M00018000/M00018622.pdf.

13 *European Competitiveness Report 2001*, European Competitiveness Report 2002.

14 See, for example *Industrial Development Report 2002/2003. Competing through Innovation and Learning,* United Nations Industrial Development Organization, 2002, http://www.unido.org/.

1.3 Introduction of the approach and main indicators

The rapid economic growth that is based upon Estonia's increased domestic demand has become an object of heated discussions. The Bank of Estonia holds the opinion that consumption and property investment must be restrained, since the economy cannot provide adequate exports to counterbalance the increasing domestic consumption; these developments may jeopardise maintaining the proper macro-economic balance which underlies all economic development.[15]

On the other hand, entrepreneurs emphasise the need for rapid economic growth that would allow Estonia to catch up with the developed countries of Europe. Overall, analysts and public policy makers are confused and cannot reach consensus about the economy's future perspectives. There seems to be a mismatch between the new situation and the mentality that has so far prevailed in Estonia.

This leads us to the question about the meaning of economic competitiveness. Intuitively, one might define competitiveness as a country's export capacity and its share of goods and services in the world market. Even a little bit more specific analysis of economic indicators would however vividly show how little we know about the competitiveness of the Estonian economy, or how little attention has been paid to its foundations so far.

Table 1. **GDP of the EU Candidate Countries**

Percentage change over previous year at constant 1995 prices.

	GDP				Household and apartment association expenditure on final consumption				State expenditure on final consumption				Gross fixed capital formation				Change in inventories (% of GDP)				Domestic demand				Export				Import				Foreign trade balance			
	98	99	00	01	98	99	00	01	98	99	00	01	98	99	00	01	98	99	00	01	98	99	00	01	98	99	00	01	98	99	00	01	98	99	00	01
EL-15	2.9	2.7	3.5	1.5	3.1	3.4	2.9	2.1	1.4	2.2	1.8	2.2	6.3	5.3	4.8	-0.4	0.5	0.3	0.3	-0.2	3.9	3.3	3.1	1.1	6.7	5.5	11.9	2.2	9.9	7.4	11.0	0.9	1.4	0.8	1.1	1.6
CS-13	3.0	0.1	5.1	-0.7	:	:	:	:	1.7	0.9	:	:	:	:	:	:	:	:	:	:	4.2	0.1	4.5	:	9.6	1.4	19.2	:	9.8	1.8	18.3	:	:	:	:	:
CS-10	3.7	3.1	4.1	2.4	:	:	:	:	1.6	1.6	:	:	:	:	:	:	:	:	:	:	5.1	3.1	3.0	0.9	10.8	4.0	18.6	9.5	13.0	3.9	15.1	:	:	:	:	:
CANDIDATE STATES																																				
Bulgaria	4.0	2.3	5.4	4.0	:	:	:	:	4.0	2.0	:	:	32.9	25.3	8.2	:	5.3	:	:	:	12.2	7.1	1.3	:	-15.6	-5.2	25.9	:	-2.8	5.1	14.6	:	:	:	:	:
Cyprus	5.0	4.6	5.1	4.0	:	:	:	:	6.4	-3.6	:	:	2.4	-0.1	:	:	1.0	1.2	:	:	9.1	0.8	5.8	4.1	-2.4	6.3	9.1	4.1	6.6	-1.9	10.2	4.2	:	:	:	:
Czech Republic	-1.0	0.5	3.3	3.3	-1.6	1.7	2.5	3.9	-4.4	2.3	-1.0	0.3	0.7	-1.0	5.3	7.2	0.9	0.3	1.6	2.2	-2.4	0.3	4.0	4.9	10.0	6.1	17.0	12.3	6.6	5.4	17.0	13.6	-6.4	-6.2	-7.0	-8.8
Estonia	4.6	-0.6	7.1	5.0	4.3	-2.7	6.7	4.8	4.5	3.8	0.1	2.1	11.3	-14.8	13.3	9.1	-0.3	-0.5	2.8	2.0	6.3	-5.9	8.4	7.0	12.0	0.5	28.6	-0.2	12.9	-5.4	27.9	2.1	-20.8	-9.0	-9.6	-14.1
Hungary	4.9	4.2	5.2	3.8	5.2	:	:	:	1.8	8.5	:	:	13.3	5.9	7.7	3.1	7.4	6.6	7.1	5.5	7.8	4.0	5.2	2.0	16.7	13.1	21.8	9.1	22.8	12.3	21.1	6.3	-2.7	-2.5	-2.4	-0.1
Lithuania	5.1	-3.9	3.8	5.9	:	:	:	:	22.9	-17.5	-0.7	0.4	9.9	-6.3	-3.9	10.6	3.1	1.8	-0.1	2.2	2.3	1.8	0.2	6.4	-24.8	12.3	12.9	20.8	-21.2	17.9	4.5	17.7	-18.8	-25.8	-21.5	-22.0
Latvia	4.8	2.8	6.8	7.7	:	:	:	:	6.1	0.0	-1.9	-2.1	44.0	-4.0	20.0	17.0	-2.5	-3.5	-7.9	-4.7	13.1	2.6	3.3	10.9	4.9	-6.4	12.0	6.9	19.0	-5.2	4.9	12.6	-11.7	-11.4	-7.7	-10.7
Malta	3.4	4.1	5.5	-0.8	2.5	6.1	6.7	:	-4.0	-0.6	5.4	2.9	:	:	:	:	:	:	:	:	-1.1	5.8	10.9	-6.0	8.1	8.2	5.6	-4.9	2.5	10.1	11.4	-10.2	-2.3	-4.1	-9.4	-3.6
Poland	4.8	4.1	4.0	1.1	:	:	:	:	1.4	1.0	:	:	14.2	6.5	:	:	1.2	1.0	:	:	6.4	5.0	2.6	-2.5	14.3	-2.6	23.2	10.8	18.5	1.0	15.6	-0.1	-3.4	-3.9	:	:
Romania	-4.8	-1.2	1.8	5.3	:	:	:	:	1.8	-9.4	4.2	:	-5.7	-4.2	5.5	:	-0.4	-0.7	0.9	:	0.2	-4.6	5.9	:	-1.6	10.8	23.9	:	11.3	-1.1	29.1	:	:	:	:	:
Slovenia	3.8	5.2	4.6	3.0	:	:	:	:	5.8	4.6	3.1	3.2	11.3	19.1	0.2	-1.9	1.1	1.2	1.2	0.6	6.0	9.1	1.1	0.5	6.7	1.7	12.7	6.2	10.4	8.2	6.1	2.1	-3.6	-7.4	-3.9	-1.3
Slovakia	4.0	1.3	2.2	3.3	5.8	-0.2	-3.4	4.0	4.0	-6.9	-0.9	5.2	11.0	-18.5	-1.4	11.6	-1.3	-1.6	3.5	3.8	6.9	-6.2	-2.5	7.3	13.2	5.2	13.8	6.5	16.9	-6.3	10.2	11.7	-10.7	-2.4	-0.2	-4.2
Turkey	3.1	-4.7	7.4	-7.4	:	:	:	:	7.8	6.5	7.1	:	-3.9	-15.7	16.9	-31.7	-0.3	1.6	2.3	-1.4	3.1	-4.7	7.4	:	12.0	-7.0	19.2	7.4	2.3	-3.7	25.4	-24.8	-3.4	-4.6	-7.1	5.9

: Data missing

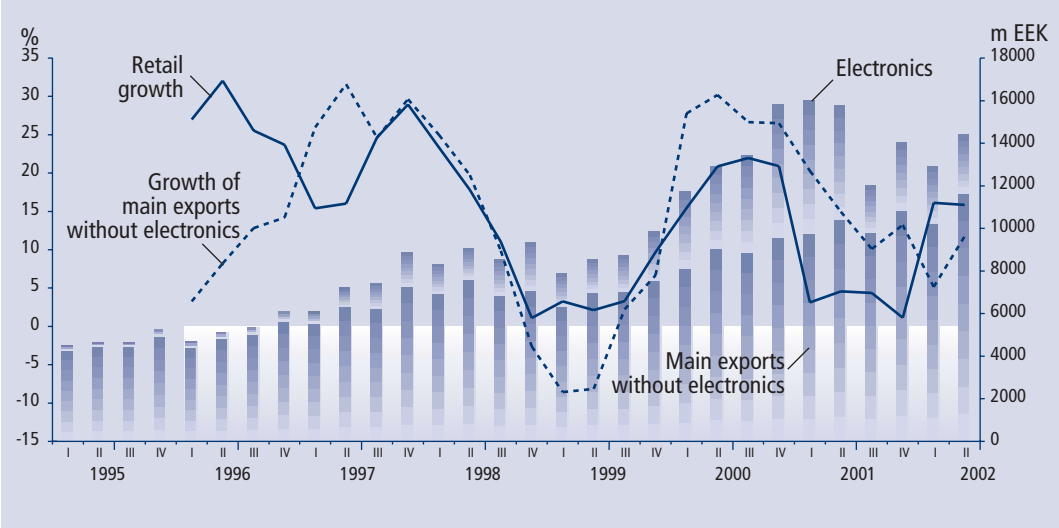
Sources: *GDP of the Candidate Countries 2001*, Eurostat, June 2002.

[15] Various press releases and articles by the Bank of Estonia in 2002.

According to the Statistical Office, Estonia's main export[16] as a whole declined substantially during the second half of 2001, after which there were some signs of improvement (Figure 2). In the majority of cases this would be an adverse signal for the economy. It has often been overlooked, however, that this decline in exports was largely due to the drastically reduced exports of the electronics sector. On the other hand, a superficial analysis would lead to some consolation from the fact that the absolute majority of the extraordinarily rapid growth of the exports of the electronics sector in recent years can be attributed to only one company, whose exports in its heyday made up nearly 40% of the Estonian total (*sic!*).[17] With considerable certainty, one can see the connection between the majority of the decline in exports during the second half of 2001 and the sharp decline in the abovementioned company's production capacity in Estonia.[18]

Despite the decline in the growth rate in 2000 compared to the earlier period, and the ebbing fortunes of the information technology sector, Estonian exports still continued to demonstrate a relatively vigorous growth rate of about 10% in 2001 and 2002 (Figure 2).

Figure 2. **Estonia's main export and retail trade growth**



Sources: Statistical Database, Statistical Office of Estonia, October 2002.

The relatively unfavourable foreign trade balance in 2002 can probably be put down to the more active money lending induced by the last decade's lowest interest rates, the rapid growth of retail trade, the completion of privatisation and the somewhat more modest foreign direct investment in Estonia.

In spite of the aforesaid, we cannot conclude much about the competitiveness of the Estonian economy. The purpose of economic development is to raise the standard of living but so far we have examined no indicators that would allow us to assess how much wealth has accrued to Estonia.

However, one thing is clear: both the need to restrain domestic consumption and/or the need for lower wages indicate that the economy is not competitive or its competitiveness has declined rather than speak of its strength.

Michael E. Porter, professor at Harvard University and advisor of the governments of the United States of America and several other developed countries, emphasises in his review prepared for the World Economic

[16] Export of goods produced in Estonia and owned by the Estonian legal persons, re-export of goods imported temporarily for processing and deliveries for the reserves of vessels and aircrafts of foreign countries (main export does not include the re-export of goods into foreign states from customs warehouses).

[17] Tarmo Pihl, *Estonian ICT cluster: Present State and Future Outlooks. Working Paper*, Estonian eVikings, Tartu 2001.

[18] *Elcoteq Annual Report 2001*, www.elcoteq.fi: "Largest downsizing took place in Estonia and Hungary...", on the conservation of the additional production capacities in Tallinn, closing down the production in Hungary and opening a plant in China.

Forum that the main reason for the inability to secure economic development is the erroneous understanding of competitiveness. This often leads countries to a situation in which they are forced to restrain domestic demand and the growth of average wage in the country in order to maintain a macro-economic equilibrium and promote exports. A "collective wage cut" by means of devaluing a national currency is not rare. Porter sums up the foundations of economic competitiveness as follows: "The living standard of a country is determined by the productivity of its economy measured by the value of the produced goods and services per one unit of human, capital and natural resources. Productivity depends on the value of the goods and services produced in the country which is measured by their free market price, and the efficiency with which they can be produced."[19]

Thus productivity is the basis for competitiveness, and failure to understand this is an essential fault of the narrow market-based view. It is adequate productivity that can allow a country to maintain a strong currency accompanied by a high living standard. Export per se as a final goal is worth nothing - the export of low-priced products which can scarcely cover the minimal wage level is utterly inadequate for economic prosperity. What really counts and allows wages to increase is productivity in manufacturing high quality products.[20]

Consequently, in order to achieve foreign trade balance of the economy, it is necessary to increase the added value produced in Estonia. The main challenge of Estonia in securing economic development is the creation of conditions for rapid and sustainable productivity growth. In this process it is important to have a stable macro-economic environment which is a vital precondition for development. At the same time, one must not forget that welfare and added value emerge at the micro-economic level, depending on the ability of companies to create valuable products and services effectively.

Each company wishing to succeed in the open economy must make a strategic choice as to whether to be the market leader at possibly low costs (*cost leadership*) or to offer high(er) quality products that differ from others.[21]

The strategy of the cost-leader presupposes efficient-scale equipment, aggressive cost control, extremely limited expenditure on R&D activity, servicing, sales network and advertising, etc. The materialisation of this strategy is often very capital intensive. The main protection against competition that such a company can have lower costs than those of competitors, which allow the company to make profit even if its competitors are unable to produce profits due to the price race.

The key to the alternative - *differentiation strategy* - is the ability to offer products and services that have no comparable alternatives in the market; to be innovative. Innovation offers higher profits and protection against competition thanks to the uniqueness of the products and customer loyalty, since competitors must offer even more superior products/services in order to succeed.

The successful operation of either choice presupposes that the structure of the company and individual operations correspond to the chosen strategy. Therefore the above-mentioned strategic choices are mutually exclusive, and the inability to pursue either of the strategic choices corresponding to the target market will generally lead to failure.

However, a company's choice of strategy is not a mere rational choice between good and bad. Either strategy may be successful; however, success depends on the number of competitors and competitive advantages. As a general rule, these depend on the broader socio-economic framework or the institutional structure of markets. The latter comprises a broader macro-economic policy, corporate legislation, the quality and nature of the labour market and the education system, and many other aspects. Thus, the choice of a business strategy largely depends on the country's (long-term) policies.

[19] Michael E. Porter, *Global Competitiveness Report 2002-2003*, Chapter. 1.2, http://www.weforum.org/gcr

[20] Michael E. Porter, *The Competitive Advantage of Nations*, London: Macmillan, 1990.

[21] Michael E. Porter, *Competitive Strategy*, New York: The Free Press, 1980.

But why then address industrial competitiveness and not that of the service sector? It is, after all, common knowledge that in the last half-century the share of the service sector in GDP has grown most of all in the developed countries?

The answer to this lies in the source of productivity growth, that is technological development. In the 1950s and 1960s, several studies attempted to measure the contribution made by technological development to economic growth (e.g. Solow 1957 footnote 8 *supra*). Their conclusion was that the lion's share of productivity growth can indeed be attributed to technological development. The same is confirmed by virtually all great thinkers who have studied the foundations of economic growth since the discipline of economics emerged as a branch of modern science. Irrespective of their position on the political right- or left-wing scale, they have virtually unanimously found that the main driving force in the formation of a market economy is technological development.[22]

Therefore, productivity growth in the industrial sector is extremely important while the potential for productivity growth in the agricultural and services sectors is far more limited.[23] "[In the service sector] there is normally very little difference in productivity between First World and Third World workers. A bus driver, a barber, or a chambermaid is about as productive in Bolivia or Haiti as they are in Norway or Italy."[24] At the same time, improved productivity in the manufacturing industry will compensate for the relatively lower growth potential of other sectors and will thus increase the productivity of the economy in general. The economy is growing and developing towards greater productivity, and the latter is primarily created by the industrial sector.

The present review will focus on mapping the industrial situation and elaborating measures to enhance its potential, using the central approach and indicators of the United Nations Industrial Development (UNDIO).[25] Attention is paid to four groups of variables:

– added value in the manufacturing industry;
– technological structure of the manufacturing industry;
– exports of the manufacturing industry;
– technological structure of exports.

These indicators characterise the *demand* side of the research and development activity and the innovation system in the best way. The strength or weakness of these indicators in international comparison shows the competitiveness of the Estonian economy as well as the factors facilitating or inhibiting it.

[22] Linsu Kim, Richard Nelson, *Technology, Learning, and Innovation. Experiences of Newly Industrializing Economies*, Cambridge University Press, 2000; Adam Smith, The Wealth of Nations, London, Campbell, [1776] 1991; Karl Marx, Capital, New York, Modern Library, [1867] 1934; Joseph Schumpeter, The Theory of Economic Development, Cambridge, MA: Harvard University Press, [1911] 1968.

[23] Ha-Joon Chang, *The Political Economy of Industrial Policy*, New York: St. Martin´s Press, 1994, p. 58.

[24] Erik S. Reinert, The Role of the State in Economic Growth. *Journal of Economic Studies*, 1999, 26, 4/5, 268-326, 275.

[25] *Industrial Development Report 2002/2003. Competing through Innovation and Learning*, United Nations Industrial Development Organization, 2002, http://www.unido.org/.

[26] R. Whitsell, "Why does the Soviet economy appear to be allocatively efficient?", *Soviet Studies* 1990, 42, 2, pp. 259–268.

2. Sources of Estonia's Economic Growth in the 1990s

2.1 Low productivity - a legacy of the Soviet period

We have demonstrated above that the competitiveness of an economy and the concurrent quality of life mainly depends on productivity. As a matter of fact, the failure of Soviet-style socialism and especially its inability to catch up with the GDP growth and high standard of living in the developed industrial countries was primarily caused by its inability to ensure an adequate increase in productivity.[26]

Regaining independence, most EU candidate countries in Central and Eastern Europe inherited a relatively large industrial sector from the period of central planning. Initially, because of considerable structural distortions and inefficient production the high degree of industrialisation proved to be a weakness rather than an advantage. Among other problems, it was also the cause of the underdevelopment of other sectors, especially services.[27]

Upon transition to market economy in Central and Eastern Europe several factors, such as the loss of export markets, abrupt liberalisation of trade, the changed macro-economic policies and inadequate industrial restructuring, brought about an industrial decline. By 1993 most states had overcome the first recession; later, however, several states had to face industrial problems again. The Baltic States (especially Latvia and Lithuania) grappled with a severe industrial crisis right into the mid-1990s.[28]

One of the main challenges faced by the transition countries is replacing the old capital base. The reinvestment system employed under central planning left today's candidate countries with a lot of capital stock that in the conditions of a market economy and international competition appears to be largely useless. Even human capital, often cited as a major strength of formerly centrally planned economies, has in many instances proved inadequate for a market economy. Therefore, new investment in both physical and human capital is the main engine of economic growth in the transition countries.[29]

The radical steps taken in the first half of the 1990s in opening up the Estonian economy and achieving a macro-economic equilibrium triggered the rapid development of Estonia into an investment-based economy.[30] Like in other countries in a similar phase of development, privatisation opened the door to the inflow of foreign investment necessary for economic growth, thereby helping to balance the deficit in the foreign trade balance.

However, against the backdrop of these generally positive developments, the growth of the real wage in Estonia at a level that outruns productivity growth rate (Figure 3) may become a serious problem. In the last year and a half it has continuously generated additional pressure on the foreign trade balance, and aggravated maintaining of the macro-economic equilibrium.

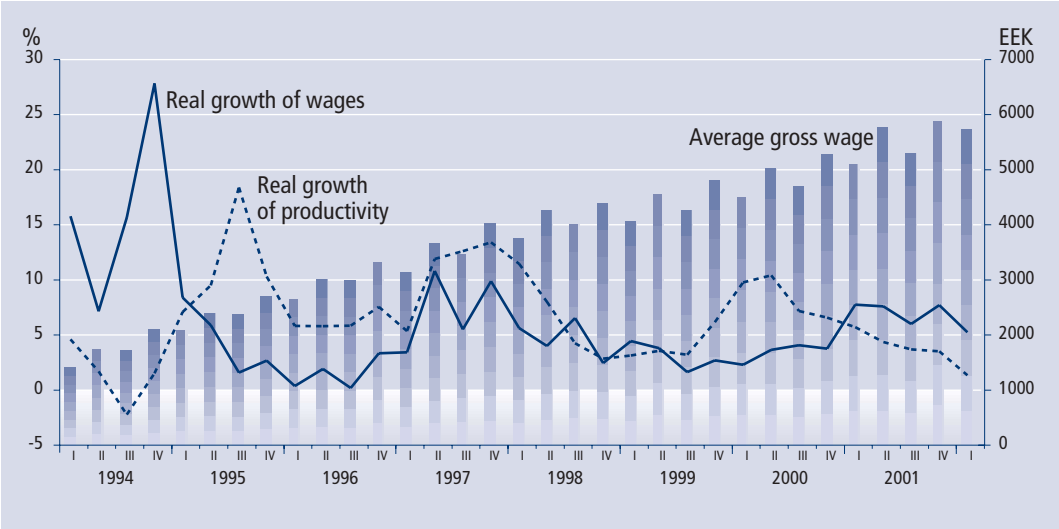
[27] Michael Landesmann, "Structural Change in the Transition Economies, 1989 to 1999", *Economic Survey of Europe*, UN Economic Council of Europe, Geneva 2000, 2/3, pp. 95-117.

[28] Peter Havlik, Productivity Catch-up and Export Specialisation in CEE Manufacturing Industry, WIIW, May 2001.

[29] Nauro F. Campos, Fabrizio Coricelli; *Growth in Transition: What We Know, What We Don't, and What We Should*, William Davidson Working Paper No. 470, February 2002.

[30] For the concept of investment based economy, see Michael E. Porter, *The Competitive Advantage of Nations*, London: Macmillan, 1990.

Figure 3. **Dynamics of wages and productivity in Estonia, 1994-2002 I quarter**[31]



Source: Statistical Office and calculations of PRAXIS.

In 2001, the productivity of the Estonian economy amounted to only 37% of the European Union's average, labour force productivity in the manufacturing industry amounted to only 26% of the EU average (Table 2).[32]

Table 2. **Labour productivity in the manufacturing sector 1998, EU15 = 100%**

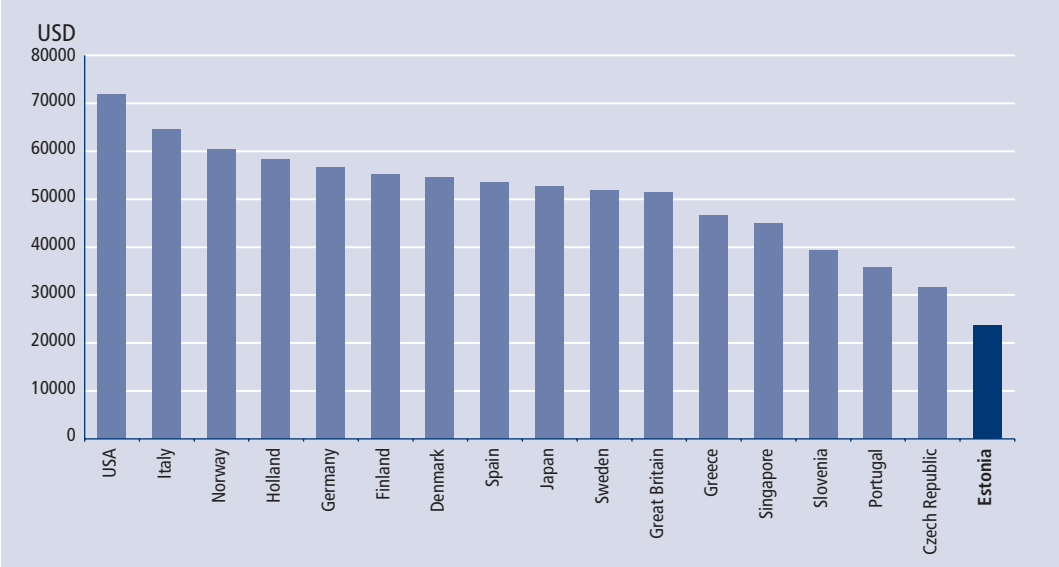
	Labour productivity in the manufacturing sector	Labour productivity of the economy
Group 1	**20–40%**	**>40%**
	Bulgaria	Bulgaria
	Latvia	Latvia
	Estonia (26%)	Lithuania
	Lithuania	Romania
	Romania	Estonia (37%)
	Poland	Poland
Group 2	**40–80%**	**40–80%**
	Slovakia	Turkey
	Hungary	Slovakia
	Turkey	Portugal
	Portugal	Hungary
	Czech Republic	Czech Republic
	Greece	Slovenia
	Slovenia	Greece
Group 3	**80%>**	**80%>**
	Rest of EU	Rest of EU

Source: Eurostat, *Statistics in Focus, 2, 13/2001: Value added, employment, remuneration and labor productivity in the candidate countries.*

[31] Real wage is deflated by GDP deflator.

[32] Eurostat *Statistics in Focus, 2 No 13/2001: Value added, employment, remuneration and labor productivity in the candidate countries.*

Figure 4. **Productivity per worker on the basis of the GDP PPP (2001)**



Source: IMD World Competitiveness Yearbook 2002.

A closer examination of the foundations of labour productivity in Estonia makes one feel that, compared to the European Union, nearly half of the blame for backwardness of labour productivity in Estonia can be put on the low productivity in the industrial and public sector (including education, health and social welfare services) (Table 3).

Table 3. **Most influential sectors as a source of productivity gap to the EU, end of 1999**

	Estonia	Poland	Czech Republic	Slovakia	Hungary	Slovenia
Industry	**31.9%**	40.6%	39.2%	38.1%	34.5%	51.5%
Public sector	25.9%	23.5%	20.7%	29.2%	32.1%	20.1%
Services (except for business)	19.7%	14.8%	20.3%	14.4%	20.6%	12.7%
Agriculture	8.2%	12.2%	11.5%	10.1%	7.1%	7.4%
Construction	7.3%	5.8%	6.3%	8.4%	4.7%	6.4%
Business services	7.0%	3.0%	2.0%	0.0%	1.0%	1.9%

Source: Johannes Stephan, *The Productivity Gap between East and West Europe: What Role for Sectoral Structures during Integration?,* IWH 2002, p.12

During the past decade, a broad industrial restructuring occurred in Estonia and at present the share of industry in the GDP is 22.7% (Table 4), which is comparable to the economic structure of developed countries. One must take note that the share is between 30-40% in the "Asian Tigers" and other countries that are at the same level of development as Estonia. If one adds to this the data of Table 3 on the sectors causing productivity lags in the candidate countries, it appears that in terms of industrial restructuring Estonia has been one of the most successful countries; at the same time, however, these data also mean that while the other candidate countries may further increase their productivity by way of ongoing industrial restructuring, Estonia has already achieved it to a large extent. A further increase in Estonia's industrial productivity can only be driven by other factors.

Table 4. **Share of industry in the GDP and growth rate, 1996-2001 (%).**

	1996		1997		1998		1999		2000		2001	
	Share in GDP	Growth rate	**Share in GDP**	Growth rate	**Share in GDP**	Growth rate	**Share in GDP**	Growth rate	**Share in GDP**	Growth rate	**Share in GDP**	Growth rate
Electricity, gas and water supply	4.1	12.3	3.5	-2.2	3.6	-8.0	3.6	-7.4	3.3	1.2	3.3	-0.7
Mining and quarrying	1.6	7.4	1.5	13.4	1.2	-7.1	1.1	-10.5	1.0	0.9	1.0	10.0
Manufacturing	18.1	2.6	18.0	16.9	17.7	6.3	16.5	-1.0	18.1	16.7	18.4	8.2
Total	23.8	2.9	23.0	13.6	22.5	3.4	21.2	-2.3	22.3	13.3	**22.7**	7.0

Source: Statistical Office of Estonia.

Therefore, below we will examine in greater detail capital inflow, industrial restructuring and corporate innovation as the main factors that have supported the growth of Estonia's productivity to date, thereby also seeking opportunities to ensure future developments.

2.2 Foreign investment and industrial structure

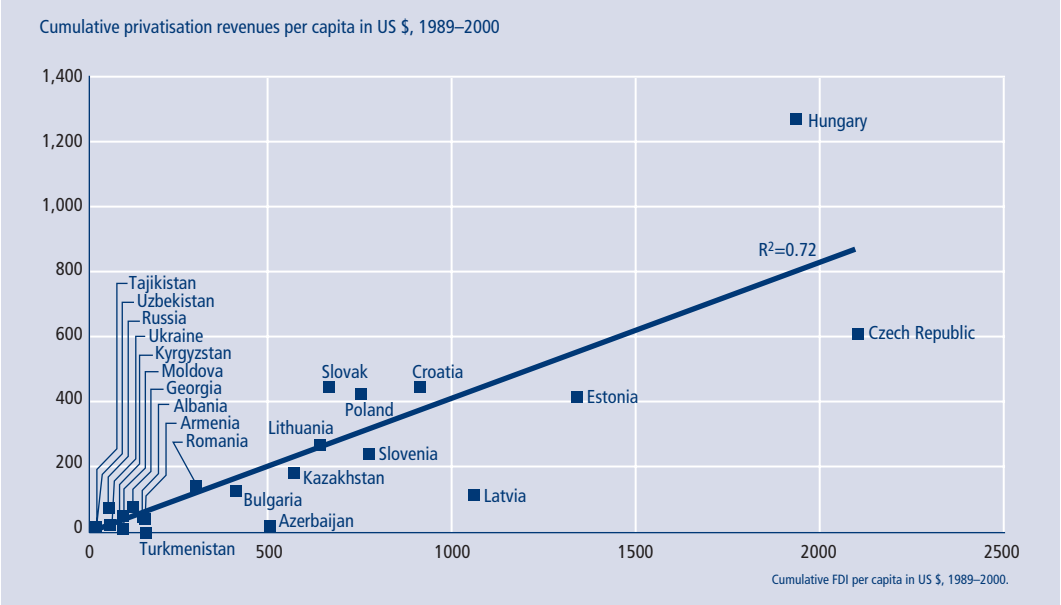
Investment is obviously one of the key prerequisites for ensuring and improving competitiveness. Naturally, this also holds true for Estonia and the other EU candidate countries, all the more so because they have inherited from the recent past a largely obsolete manufacturing base that often proves to be unviable in market economy conditions.

Recent research results demonstrate that, contrary to frequently held opinions, the transition countries also lag behind advanced countries in terms of their workforce, which has proven to be uncompetitive in free market conditions. Despite the formally high level of education, labour skills appear to be inadequate - especially at the level of skilled labour and managerial skills.[33]

Modernisation of the existing means of production and their active restructuring, and retraining of labour presuppose huge financial resources that are generally limited in all candidate countries. Foreign investment (especially foreign direct investment) plays an even more prominent role in technological renewal, improvement of managerial skills and in making market competition more effective.[34]

The European Bank of Reconstruction and Development (EBRD) data[35] demonstrate a vigorous positive correlation between the privatisation revenues earned by the transition countries and their foreign direct investment (Figure 5).

Figure 5. **Foreign direct investment and privatisation revenues per capita**



Source: EBRD, *Transition Report 2000*, London: Hyway Printing Group, 2000, p. 84.

Privatisation has so far been one of the main factors influencing the inflow of foreign investment to Estonia. In the period 1997-1999, foreign capital constituted 60% of Estonia's privatisation revenue. At the same time, privatisation funded by foreign capital constituted 70% of foreign direct investment in Estonia (Table 5).

[33] Peter Havlik, *Productivity Catch-up and Export Specialisation in CEE Manufacturing Industry*, WIIW, May 2001.

[34] Klaus Meyer, *International Business Research in Transition Economies*. Oxford Handbook of International Business, Oxford: Oxford University Press 2001; IMF, World Bank, OECD and EBRD, *A Study of the Soviet Economy*, Paris: OECD 1991.

[35] EBRD, *Transition Report 2000*, London: Hyway Printing Group, 2000, p. 84.

Table 5. **Privatisation and foreign direct investment**[36]

	1990–1996		1997–1999	
	Forex rev. in total privatisation rev., %	**Forex priv. revenue in FDI, %**	**Forex rev. in total privatisation rev., %**	**Forex priv. revenue in FDI, %**
Czech Republic	15	80	80	50
Estonia	60	33	60	**70**
Hungary	63	47	40	20
Poland	low	20	medium	40
Slovenia	low	low	low	low

Source: Gábor Hunya, *International Competitiveness Impacts of FDI in CEEC, Background Paper for Special Session III on FDI and the restructuring of transition and emerging economies*, UN Economic Commission for Europe, December 2000.

As Estonia had virtually completed privatisation by 2000-2001, we may presume that the future inflow of foreign direct investment into Estonia will go to other sectors than those that have been hitherto invested in. The Estonian Investment Agency also forecast a billion-kroon reduction in the inflow of foreign investment by 2002.[37] Although the maintenance of future investment at the current level depends on several factors, including the enlargement of the European Union and the overall development of the global economy, in the medium term developments in the Estonian industrial sector will, considering the experience of other candidate countries, be the most important.

Studies also confirm a positive correlation between different elements of the scope of the foreign capital and the economic competitiveness both at the sectoral level as well as in the economy as a whole. It is quite evident that strong participation of foreign capital in the manufacturing industry increases the international competitiveness of an economy. Therefore, during the period 1994-1998, the GDP and productivity growth, structural changes and profitability were higher in those candidate countries where foreign direct investment had stronger representation.[38]

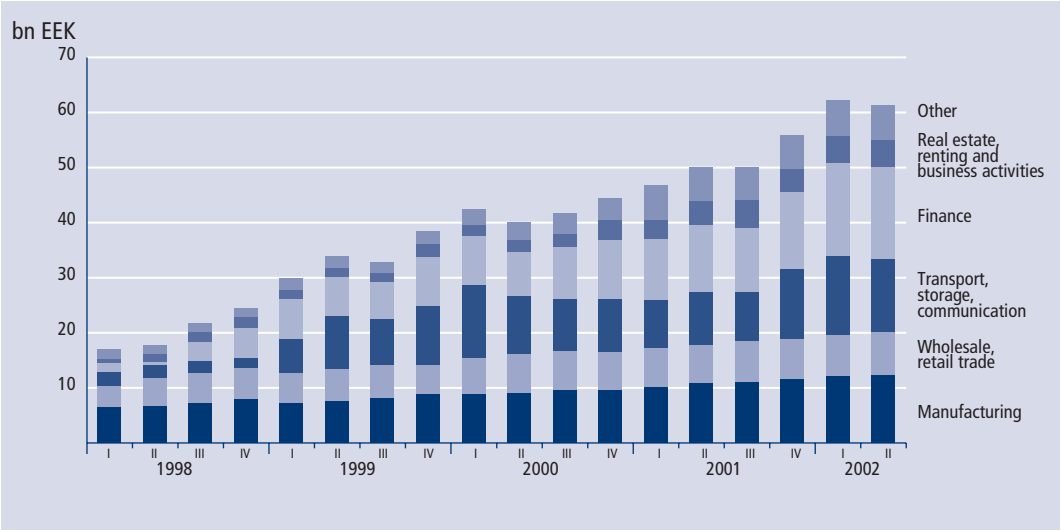
The manufacturing industry has been the main target for foreign investment in all candidate countries. In Estonia, the manufacturing industry holds only the third position as a target of investment (Figure 6). The relatively low share of the Estonian manufacturing industry in absorbing foreign investment is the result of both the weakness of this sector and the relative strength of the transportation and finance sectors.

[36] Estonia's first period: 1993–1996. – Foreign exchange (forex) revenue in total privatisation revenue could not be calculated for Poland in the first period as the value of non-cash privatisation could not be measured. Based on the relative role of various modes of privatisation, a very rough estimation could be made: 'low' means less than a quarter, 'medium' means between one quarter and a half, and 'high' means above a half. – In Slovenia the way of privatisation does not allow calculation of foreign shares.

[37] *Eesti Päevaleht*, 11 November 2002.

[38] Gábor Hunya, *International Competitiveness Impacts of FDI in CEEC, Background Paper for Special Session III on FDI and the restructuring of transition and emerging economies*, UN Economic Commission for Europe, December 2000.

Figure 6. **Foreign direct investment in Estonia by fields of activity**



Source: Bank of Estonia, http://www.ee/epbe/.

Among the candidate countries, in 1996 Estonia ranked second after Hungary in terms of foreign investment received (Table 6). This was mainly the result of the rapid opening up of the economy and privatisation that came after the introduction of Estonia's national currency based upon the Currency Board system. However, since then Estonia has fallen behind Hungary, Poland and the Czech Republic if we compare the indicators of the foreign capital-based industry. By the year 1998, the foreign sector in Estonia had not substantially increased on account of new added enterprises. The growth was mainly due to the enlargement of the existing foreign investment enterprises. Estonia, a country with little experience in modern industry, had not yet become an export-oriented production base for foreign capital.[39] Developments in this direction can only be perceived in recent years when the Scandinavian enterprises have begun a more extensive transfer of their labour-intensive production from their countries to Estonia. Regrettably, no more detailed statistical data are available about this period.

Table 6. **Share of foreign investment based industrial enterprises, main indicators (percentage)**

	Equity [40]		Employment		Investment		Revenue		Export	
	1996	1998	1996	1998	1996	1998	1996	1998	1996	1998
Czech Republic	21.5	27.9	13.1	19.6	33.5	41.6	22.6	31.5	15.9	47.0
Estonia	43.5	40.1	16.8	20.8	**41.8**	32.9	26.6	28.2	32.5	35.2
Hungary	67.4	72.7	36.1	44.9	**82.5**	78.7	61.4	70.0	77.5	85.9
Poland	29.3	43.2	12.0	26.0	30.6	51.0	17.4	40.6	26.3	52.4
Slovenia	15.6	21.6	10.1	13.1	20.3	24.3	19.6	24.4	25.8	32.9

Source: Gábor Hunya, *International Competitiveness Impacts of FDI in CEEC*, Background Paper for Special Session III on FDI and the restructuring of transition and emerging economies, UN Economic Commission for Europe, December 2000.

[39] Gábor Hunya, *International Competitiveness Impacts of FDI in CEEC, Background Paper for Special Session III on FDI and the restructuring of transition and emerging economies*, UN Economic Commission for Europe, December 2000.

[40] Equity capital is indicated in respect of Estonia and in the data of 1996 concerning the Czech Republic. Nominal capital in cash is indicated in respect of Hungary.

Thus, by most criteria foreign capital based enterprises outperform those based on domestic capital (Table 6). In most fields of activity, their capital intensiveness and labour productivity are higher; they pay higher wages and export more than domestic enterprises. On the other hand, domestic enterprises invest more in intangible assets and new machinery/equipment. Therefore, domestic enterprises should increase their technological capability in order to be able to profit from more developed foreign technology.[41]

In 1995-1999, the presence of foreign capital generally had a positive spillover effect on the modernisation of domestic enterprises.[42] As shown in Table 7, its influence was greatest in the field of leather, wood and paper, rubber and plastic and non-metallic mineral products. As a rule, in most industries foreign presence tends to be stronger in sales and capitalisation than in employment.

The table also indicates average distribution of intangible assets in each particular industry. Evidently, foreign presence differs substantially from one industry to another, although their intangible assets vary little. As could be presumed, foreign presence has not entailed large investment in intangible assets.[43]

Table 7. **Presence of foreign investment in Estonian industry**

	Number of firms			Intangible assets[44]	Foreign presence		
	Domestic	Foreign	Total		Empl.	Sales	Eqity
Food products	227	21	248	49.9%	8.4%	17.8%	25.0%
Textile products	97	30	127	2.3%	13.2%	11.3%	5.4%
Leather products and footwear	19	14	33	**2.2%**	**50.2%**	**73.0%**	**84.2%**
Wood, paper and pulp products	158	36	194	**8.7%**	**17.8%**	**24.2%**	**57.4%**
Petroleum, chemical products	37	21	58	3.2%	13.3%	20.3%	19.7%
Rubber, plastic, & non-metallic products	85	42	127	**8.6%**	**45.5%**	**68.5%**	**56.9%**
Metal products	75	17	92	0.8%	8.7%	15.1%	21.2%
Machinery and equipment	79	18	97	1.4%	10.9%	17.8%	4.5%
Electrical and transport equipment	107	30	137	4.0%	13.2%	22.2%	14.9%
Furniture and other manufacturing	72	22	94	5.9%	16.6%	25.3%	12.8%
Electricity, gas and water supply	56	5	61	0.4%	34.7%	72.7%	25.8%
Construction	199	11	210	1.7%	6.9%	8.0%	1.5%
Wholesale and retail trade	267	91	358	1.4%	12.6%	23.3%	31.9%
Total	1478	358	1836	9.8%	15.6%	25.0%	26.2%

Source: Evis Sinani, Klaus Meyer, *Identifying Spillovers of Technology Transfer from FDI: The case of Estonia*, Copenhagen Business School, April 2001, p.26.

Sinani and Meyer's analysis also confirms that investment in intangible assets (know-how, trademarks, etc.), new machinery and skilled workers increases productivity growth in domestic enterprises. One has to note, however, that in case an industry is dominated by foreign capital, these investments tend to have a relatively smaller effect on the productivity growth of domestic firms. Moreover, competition from foreign enterprises will force domestic firms to use their existing technologies as effectively as possible or to look for new ones in order to maintain their market share.[45]

41 Evis Sinani, Klaus Meyer, *Identifying Spillovers of Technology Transfer from FDI: The case of Estonia*, Copenhagen Business School, April 2001, pp. 13-14.

42 The impact of spillover entailed by foreign investment may also be negative. For example, if the foreign capital draws labour from domestic enterprises, etc.

43 Evis Sinani, Klaus Meyer, *Identifying Spillovers of Technology Transfer from FDI: The case of Estonia*, Copenhagen Business School, April 2001, p 13.

44 Ratio of intangible assets to net sales.

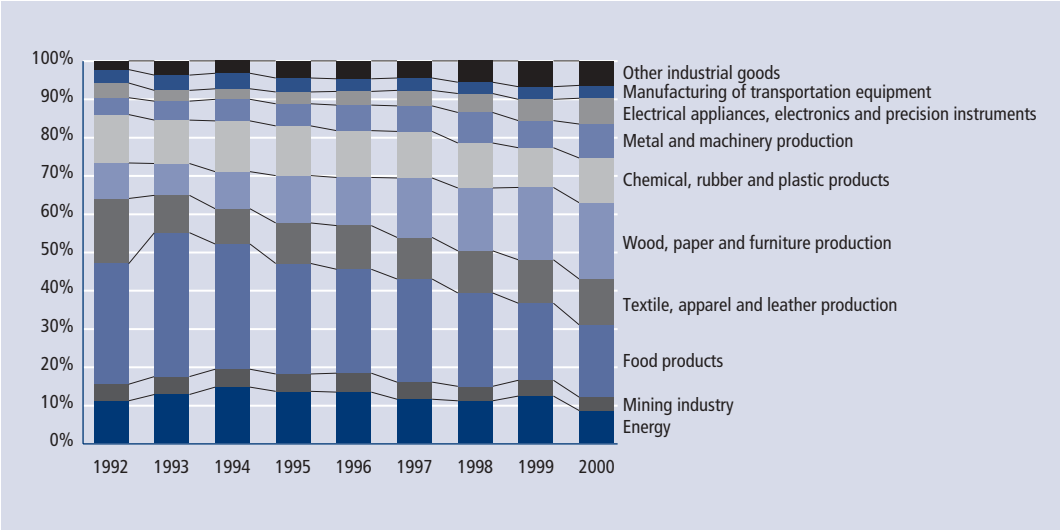
45 Evis Sinani, Klaus Meyer, *Identifying Spillovers of Technology Transfer from FDI: The case of Estonia*, Copenhagen Business School, April 2001, pp. 18–20.

It needs to be emphasised that the presence of foreign capital has a diverse impact on enterprises. Large domestic enterprises, for instance, can act as masters of their destiny. They do not gain much from the spillover effect related to the utilisation of new technology; instead they have a chance to gain from investing in intangible assets, new equipment and human resources. In contrast, small enterprises can strongly profit from the spillover effect related to the demonstration and imitation of new technology as well as from co-operation with foreign capital based enterprises, being at the same time unable to increase the profit accrued from the spillover effect by investing in intangible assets, equipment and human resources. Even more, they are losing skilled labour.[46]

Regarding domestic exporting enterprises it has to be admitted that the presence of foreign capital does not have a substantial (negative) impact on them. For them, it is their own foreign buyers that are important. However, the presence of foreign capital has a vigorous positive impact on non-exporters. In order to increase these positive effects substantially, those domestic enterprises that are oriented to the domestic market should increase their investment in new equipment.

To sum up, as compared to the year 1992, in the period of industrial restructuring the shares of energy generation, and the output of food and beverages in the structure of industrial production decreased substantially. While the shares of the wood and furniture, and the metal and machinery industry increased (Figure 7).[47]

Figure 7. **Structural changes in industrial production in 1992–2000**



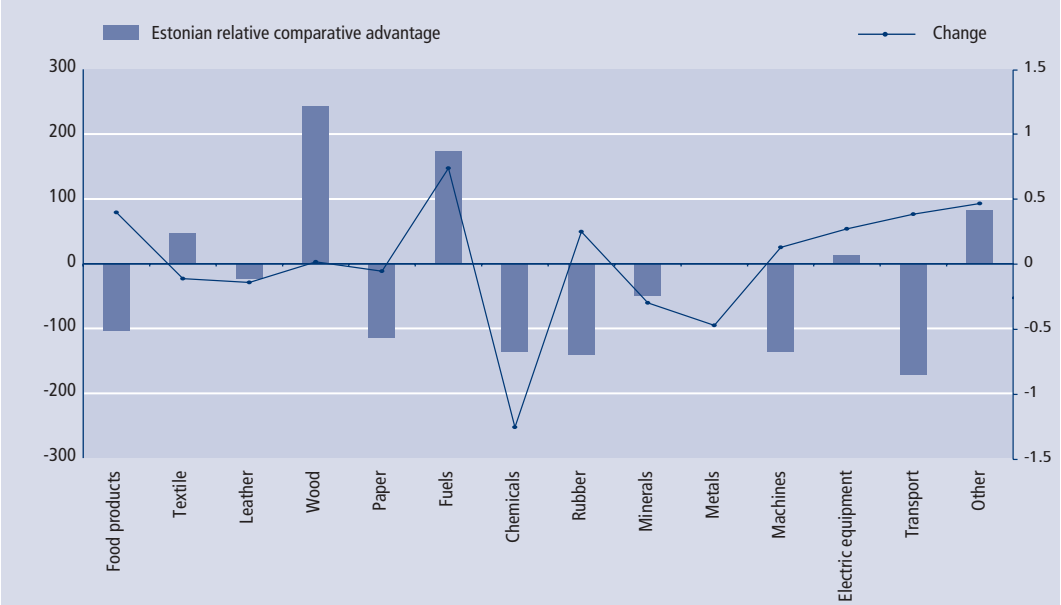
Source: Statistical Office of Estonia, October 2002.

[46] *Ibid*, pp. 19-20.

[47] A more specific review can be found in: Estonian Development Plan for Commissioning European Union Structural Funds – Single Programming Document, pp. 28–37; Overview of the Situation in the State's Economy and Main Goals of the Government of the Republic, pp. 34–45. Ministry of Finance and Ministry of Economic Affairs, Tallinn, October 2002.

In foreign trade, Estonia has revealed competitive advantages[48] in the wood and furniture industry, and to a smaller extent also in the textiles and oil shale industries. In contrast to the earlier periods, the production of food and means of transport also demonstrated positive trends at the end of the 1990s.

Figure 8. **Competitive advantages of Estonia in the export of industrial production (2000) and the changes in 1999-2000 compared to 1995-1996**



Source: Peter Havlik, *Restructuring of CEE Manufacturing Industry*, Vienna Institute for International Economic Studies, August 2002, forthcoming.

Like in the case of Estonia (Figure 8), the competitive advantages of the other Central and Eastern European transition economies lie mainly in the labour intensive (textile) and resource intensive (timber) industries, whereas the capital and technology intensive industries (for example, chemicals, machinery and equipment) are relatively uncompetitive.[49] Overall, the structure of Estonian industrial production and employment is more similar to the industrial structure of EU cohesion countries than of the "leading countries" of the European Union (Figure 33 and Figure 34 in Annex).

The fundamental conclusion to be drawn here is that *an open economy and foreign investment do not lead to an automatic change of the structure of the industry towards greater knowledge and skills intensity:* rather than that, it is the other way round.

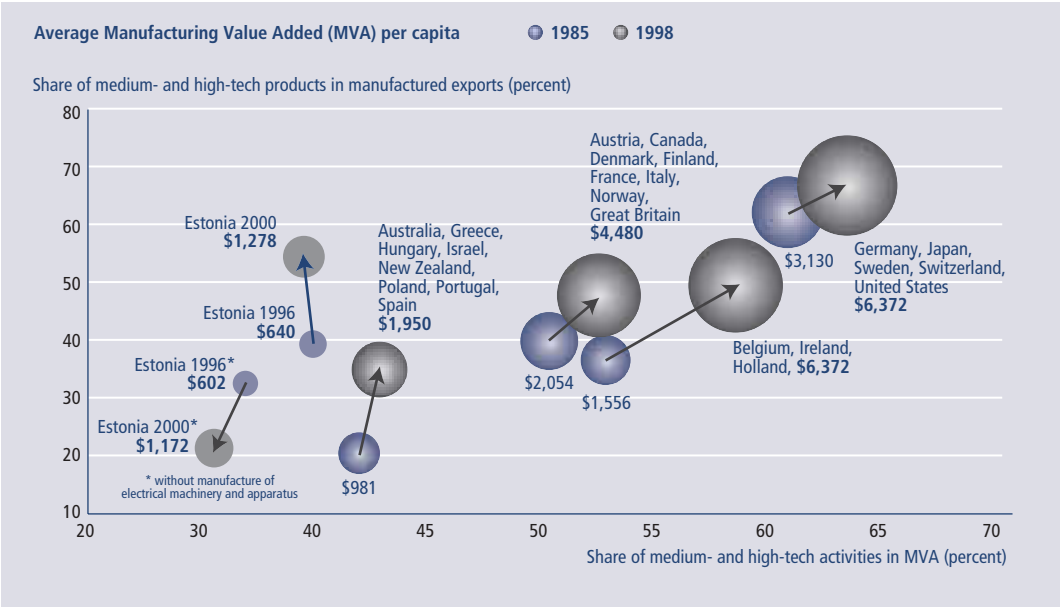
The latter is illustratively confirmed by a cluster analysis of the technological development of the manufacturing industry performed following the UNIDO methodology (Figure 9). Unfortunately, due to lack of reliable data, it was not possible to indicate Estonia's developmental dynamics between 1985 and 1998 in a similar way to other countries. Therefore, the calculations about Estonia have only used the data of the years 1996 and 2000.

Due to the large production share of one company in the production of "Electric appliances and equipment, their parts; sound recording and reproduction equipment, ...", and in the entire export of Estonia (see also Chapter 1.3), data is also presented without this particular group.

[48] Revealed competitive advantages (RCAs) compare the relative shares of exports and imports of a particular branch with the share of the country's total manufacturing exports and imports. See also Bela Balassa, "Trade Liberalisation and Revealed Comparative Advantage", The Manchester School of Economic and Social Studies, 1965, 33, pp. 99–123.

[49] Peter Havlik, *Restructuring of CEE Manufacturing Industry*. The Vienna Institute for International Economic Studies, 2002.

Figure 9. **Cluster analysis of the technological development of the manufacturing industry in industrial countries and transition economies, 1985-1998; in Estonia 1996-2000**



Source: *United Nations Industrial Development Organization, Industrial Development Report 2002/2003, Competing through Innovation and Learning*, 2002, http://www.unido.org/.
Calculations on Estonia are based on data from the Statistical Office and calculated by PRAXIS.

It appears from the above that, in Estonia the share of added value created by the middle- and high technology industries is *decreasing*. This in turn highlights that despite the enviable records of economic growth Estonia's industrial structure in 1996 was in better shape than in 2000.

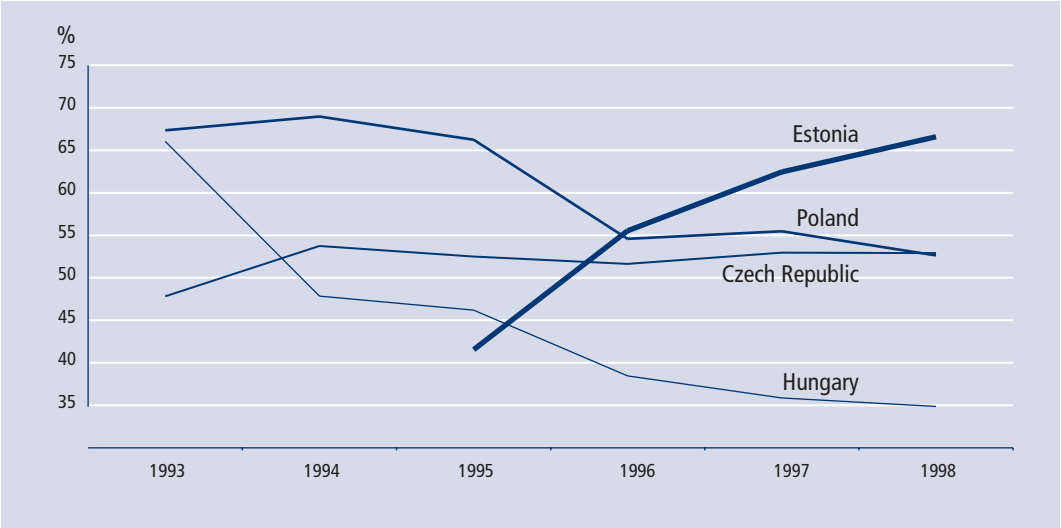
The structure of a country's industry (share of middle- and high-level technology enterprises) is one of the most obvious signs of its competitiveness. That of Estonia is decreasing.

Although specialisation of low-technology industries, the competitive advantage of which is guaranteed by the low prices of resources, as is the case in Estonia (Figure 9), seems to be unavoidable in certain stage in development, have many transition economies and most of the developed countries, owing to their active industrial policy, substantially increased the share of industries with middle- and high-level technology in their economies. Similarly, Estonia's economic policy should also have been modified during the 1990s at the latest.

2.3 Productivity growth and innovation

As demonstrated above, the relatively greater success of foreign capital based enterprises may be explained by their relatively higher technological level, which is often unattainable for domestic enterprises due to several reasons.[50] The main positive impact of foreign investment in industry is related to the application of new technology (technology transfer) and the relatively effective production of export items.[51]

Figure 10. **Productivity convergence: domestic and foreign capital based companies**



Source: Mark Knell, *Foreign direct investment and productivity spillovers in the accession countries*, http://eu-enlargement.org/discuss/nrpaper.asp?topic=research&projectid=97, 2000.

In 1995, the productivity of Estonian domestic capital based enterprises constituted only 40% of that of foreign capital controlled enterprises. Such differences between the productivities of domestic and foreign capital dominated enterprises as well as industries are characteristic of virtually all the candidate countries. These productivity differences have even increased over time in the countries with more industry in need of modernisation and whose privatisation has progressed less rapidly.[52]

[50] For the sake of a comprehensive picture, it has to be considered that, so far, foreign capital has not brought the best existing technology to Estonia and this in turn causes a difference in the productivity and know-how intensiveness of international corporations and foreign capital active in Estonia.

[51] Gábor Hunya, *International Competitiveness Impacts of FDI in CEECs*, Barcelona, September 2000, p. 13.

[52] At the same time, one has to remember that the countries compared also differ in their levels of productivity (Figure 4).

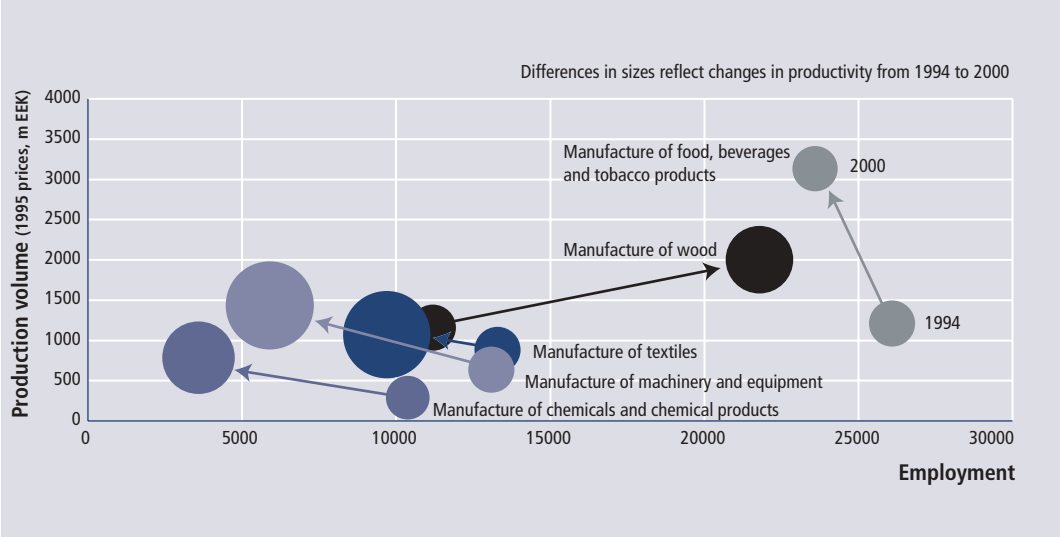
An analysis of the productivity growth indicators of the manufacturing industry of Estonia (Figure 11 and Table 8) during the period 1994 - 2000, allows us to draw the following important conclusions:

– Between 1994 and 2000, the productivity of the manufacturing industry in Estonia has increased on average by 8.2% per annum[53] mainly due to technology transfer, but also organisational changes, the introduction of new methods of management and the reorganisation of business processes.

– The decline in productivity experienced earlier in some branches of the manufacturing industry[54] has been replaced by continuous productivity growth. The reasons for this are the completion of the privatisation process and larger restructuring processes.

– Industries with the highest productivity growth are characterised by less employment (jobless growth industries), i.e. the productivity growth is due to capital investment, which clearly shows that the Estonian economy is in the stage of investment-based development.

Figure 11. **Productivity, employment and gross production in selected branches of industry, 1994–2000**[55]



Source: Statistical Office of Estonia, calculations by PRAXIS.

[53] Statistical Office, calculations by PRAXIS.

[54] For examples see Hannu Hernesniemi, *Evaluation of Estonian Innovation System*. PHARE Support to European Integration Process in Estonia, 2000, pp. 12–14.

[55] Different sizes of the dots denote changes in productivity. The bigger dot denotes the year 2000, as productivity has increased in most branches.

Table 8. **Changes in employment in the manufacturing industry, total production and annual productivity growth during the period 1994-2000**[56]

	Production decreasing		Production increasing	
Employment increasing			16.2%	manufacture of wood
			13.6%	manufacture of furniture and other manufactured goods
			13.3%	manufacture of motor vehicles and other transport equipment
			10.0%	manufacture of rubber and plastic products
			9.1%	manufacture of electric appliances
			8.6%	manufacture of metal products
Employment decreasing			36.01%	tanning and dressing of leather and manufacture of footwear
	25.40%	manufacture of chemicals and chemical products	25.40%	manufacture of textiles
	4.62%	mining	20.71%	manufacture of other non-metallic mineral products
	2.86%	energy supply	12.73%	manufacture of paper and paper products
	0.05%	manufacture of food. beverages and tobacco products	9.11%	manufacture of machinery and equipment
			4.09%	manufacture of wearing apparel

Source: Statistical Office, calculations by PRAXIS.

As Estonian industry is mainly subject to the groups of supplier dominated activities[57] and production intensive activities,[58] technological transfer has been the most important method enabling productivity growth (see also 2.4).

The nature of innovation processes in various countries being different, a general innovation indicator cannot be uniformly applied to all the countries in Europe. Therefore, an international comparison should separately view the countries at the investment based stage and those at the innovation based stage since the main driving force of the technological development of the former is the application of new technology (technology transfer) and of the latter the R&D activity with the aim of elaborating new technology.[59]

Therefore it is not surprising that, according to the survey conducted in Estonia in the spring of 2002,[60] the number of innovative enterprises constituted 36% of the total number of Estonian enterprises, which is a relatively high indicator compared to the European countries. Taking into account the reorganisation of the industrial and services sectors of the country and large-scale capital investment, this high indicator is not surprising. Yet, it is still not as big as the respective indicator of Ireland four years ago.

According to study by Kurik et al, in 2000, Estonia's industrial sector spent 2.3% of its turnover on innovation; the respective indicator for the services sector being only 0.8%. In 1996, the corresponding indicators of the EU countries were 4% and 3%. At the same time, novel or modernised products of an enterprise constituted only 17% of the sale of Estonia's industrial output, which is twice as low as the respective EU average.[61]

[56] Percentage indicates the average annual industrial productivity growth/decrease.

[57] For example, agriculture, textile industry, forestry. In respect of the classification, see Keith Pavitt, "Sectoral Patterns of Technical Change: Towards a Taxonomy and a Theory". *Research Policy*, 1984, 13, pp. 343–373.

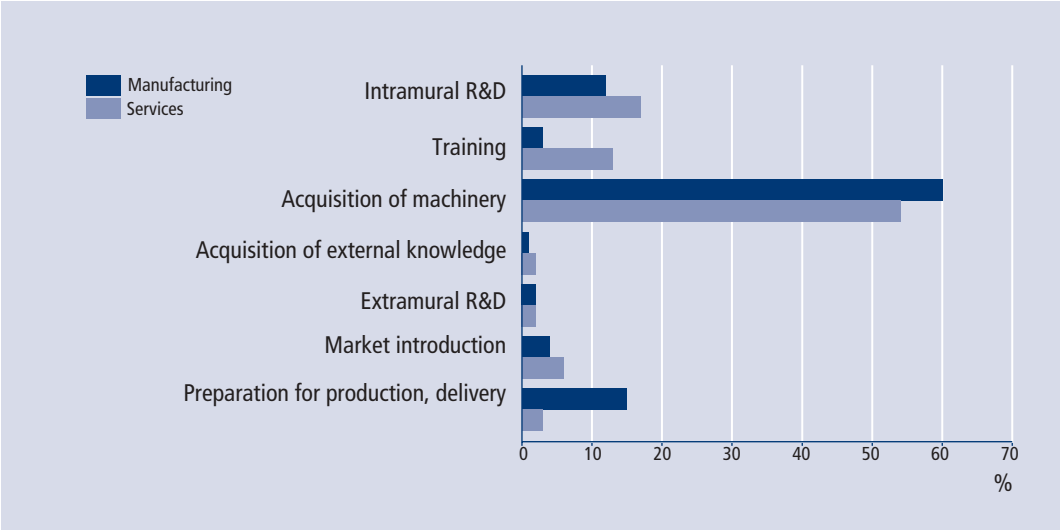
[58] Fields of activity with the scale-effect: for example, cement industry, glass industry, metal industry.

[59] On the comparability problems of CIS research conducted in different countries see also Hans Lööf, Almas Heshmati, Rita Asplund and Svein-Olav Nåås , "Innovation and Performance in Manufacturing Industries: A Comparison of the Nordic Countries", *SSE/EFI Working Paper Series in Economics and Finance*, No. 457, 2001.

[60] Silja Kurik, Rünno Lumiste, Erik Terk, Aavo Heinlo, *Innovation in Estonian Enterprises 1998-2000, Community Innovation Survey 3*, 2002. The research conducted in Estonia is describing the innovation activity of companies and is based upon the methodology of the innovation research of the European Union – Community Innovation Survey.

[61] Novel products in the market constitute only 11% of the sale of the industrial production.

Figure 12. **Distribution of companies' innovation expenditures in Estonia, 2000**



Source: Silja Kurik, Rünno Lumiste, Erik Terk, Aavo Heinlo, *Innovation in Estonian Enterprises 1998-2000, Community Innovation Survey 3*, 2002.

In Estonia, the most important element of innovation is the acquisition of new machinery and equipment (Figure 12), while the share of R&D is relatively small.[62] An analysis of the reasons why companies become involved in innovation, and the impact of innovation on their productivity (Figure 11, p. 15) leads us to conclude that the main reason for dealing with innovation in the branches of higher productivity growth is the expansion of market share and production capacity. Namely this is what happens via capital investment, i.e. technology transfer, as argued in the previous section on the basis of other data.

[62] The statistical data is only once verified, although other statistical and/or analytical data, namely in the case of R&D financing, where the estimation given by enterprises and by the official government data differ as much as *three* times. Obviously, it may also be very useful to verify other data as much as possible.

2.4 Basis for Estonia's current economic success

On the basis of the above said, we can justifiably claim that in Estonia the engine of the productivity growth of the last decade and hence of economic development in a broader sense has been the technology transfer invoked by foreign investment, which triggered productivity increase in the economy.

Many international surveys have reached the same results, concluding that foreign capital has been the leading agent of innovation in the Central and Eastern European transition countries.[63]

Productivity growth in Estonia and the other candidate countries has mainly derived either from the activity of domestic and foreign enterprises in establishing new enterprises or from foreign direct investment in those sectors that foreign enterprises have been interested in restructuring. Although the difference has been reduced with years, the enterprises that have been modernised in this way still seem to be outperforming domestic enterprises.[64]

Abramovitz and Verspagen have proposed a simple but perspicacious *catching-up* theory,[65] according to which there is an almost one-to-one correlation between the first stages of economic catch-up and how extensively imported new technologies, work management and know-how from the developed countries are spread. Therefore, in the first stage, upon the opening of borders and the stabilisation of the macro-environment, it seems that the economy is growing by itself.

Nevertheless, it would be incorrect to presume that the productivity growth based upon catching-up can continue in the same way, since the quality of foreign investment and the transferred technology will become more and more important. The latter is largely dependent on the quality of the domestic industry and the labour market, but also on the level of university (engineering) and vocational education in a broader sense.

However, in Estonia we have mainly received investments directed at resource-intensive and low-skilled employment. Although this has been inevitable, it is about to create a closed circle in respect of technological transfer: it is traditional technology corresponding to the local labour market that is brought to Estonia to be fostered here, rather than high technology or research results.

The decisive role of the level of education in the catching-up process is also vividly illustrated by the example of the unification of Germany 10 years ago. Despite huge investments made in East Germany, labour productivity there has not caught up with the West German level. The general statistical indicators of the level of education, often used in respect of the candidate countries, fail to reflect the actual level of education and whether or not it meets the needs of the labour market. This is confirmed by the widely accepted fact that the existing and growing unemployment is largely structural.[66]

The above-mentioned innovation survey also revealed that enterprises possessing foreign capital in Estonia are 1.5 times more innovative than those based on domestic capital, and enterprises belonging to an international group are almost twice as innovative as all the rest, which confirms the occurrence of technological transfer. At the same time, however, it shows that it is almost impossible for domestic enterprises - especially medium and small size enterprises - to be innovative in today's context because they lack both capital and labour required for that.

The foreign investors starting activities in Estonia, have been guided in their selection of strategy by their wish to be leaders both in Estonia and in their domestic markets with their low costs. At the same time, enterprises based on foreign capital and oriented to the global market and export are integrated in

63 Michael E. Porter, *Building the Microeconomic Foundations of Prosperity: Findings from the Microeconomic Competitiveness Index*, Global Competitiveness Report 2002-2003, Harvard University and World Economic Forum, November 2002; Slavo Radoševic, *Assessing innovation capacities of the Central and East European Countries in the enlarged European innovation system*, 2002, http://www.iwh-halle.de/projects/productivity-gap/prelim_results/WP3_Radosevic_01.pdf.

64 Slavo Radoševic, David Dyker, *Technological Integration and Global Marginalisation of Central and East European Economies: the Role of FDI and Alliances*, STEEP Discussion Paper No. 34, September 1996.

65 Moses Abramovitz, "*Catching Up, Forging Ahead, and Falling Behind*", *Journal of Economic History*, 1986, 46, 2, pp. 385-406; Bart Verspagen "A New Empirical Approach to Catching up and Falling behind", *Structural Change and Economic Dynamics*, 1991, 2, 2, pp. 359-380; Bart Verspagen, *Uneven Growth Between Interdependent Economies: An Evolutionary View on Technology Gaps, Trade and Growth*, Maastricht: Universitarie Pres, 1992.

66 Erich Gundlach, *Human Capital Formation: What pre-accession countries can learn from the EU experience*, IPTS Report, June 2002, http://www.jrc.es/pages/iptsreport/vol65/english/STR1E656.html.

a concern through a parent company, and if there are no other reasons to be in Estonia, except for a low-cost expenditure base, they are very mobile and prepared to withdraw if the expenditure level increases. As most of the transition economies are privatising and conducting institutional reforms like Estonia, Estonia may foresee the emergence of a large number of direct and indirect competitors in the coming years. Many Central and Eastern European countries, not to mention China and India, appear to be more attractive for entrepreneurs who have based themselves upon the Estonian resources until today. Some examples are already at hand: in 2001, AS Elcoteq Tallinn effected large personnel cuts namely in Estonia and Hungary due to the ebbing fortunes of the information technology sector.[67]

In the coming years, Estonia can still count on some cheap labour based competitive advantages. Therefore, different analyses of economic competitiveness[68] have made fairly favourable forecasts for Estonia's economic development in the coming years. On the other hand, in the medium and long-term perspective, if the specialisation trend of the 1990s continues, the Estonian industry may become locked into low technologies and a low level of income. Compared with the industrial structures of the other Central and Eastern European countries, Estonia is in the most miserable state, which will become practically hopeless if the current specialisation continues. Research results showing that unless the present industrial structure is changed, Estonia will never be able to catch up with the economic level of the European Union, provide more than adequate reason for taking action.[69]

[67] *Elcoteq Annual Report 2001*, www.elcoteq.fi

[68] *Global Competitiveness Report 2002-2003*; *World Economic Forum*, November 2002; *IMD World Competitiveness Yearbook 2002*.

[69] Johannes Stephan, *Industrial specialisation and productivity catch-up in CEECs, patterns and prospects*, IWH, June 2002, p. 16, http://www.iwh-halle.de/projects/productivity-gap/.

3. Foundations of the "high-wage strategy"

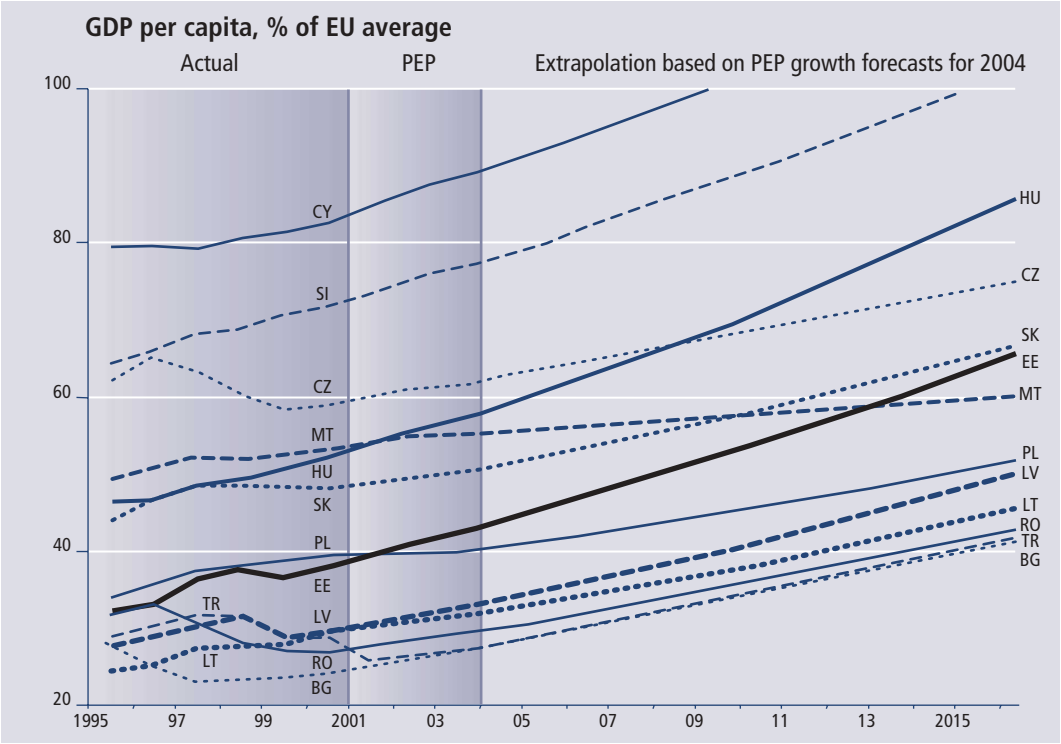
3.1 Economic convergence in the European Union

The previous chapters attempted to clarify the bases of the Estonian economic development to date. In what follows we will try to contemplate a strategy that might allow a rapid economic advance for Estonia and the country's smooth convergence with the European economic area.

Estonia will, in all likelihood, become a full member of the European Union in 2004. The wider public's elevated expectations associate EU membership with rapid economic convergence and fast approximation of the local standard of living to the EU average.

At the same time, a simple extrapolation on the basis of the information gathered by the European Commission from the pre-accession economic programmes (PEP) of the candidate countries shows that if Estonia managed to ensure a 5.5% annual economic growth, it would take the country 20 years to reach 75% of the EU average GDP per capita.

Figure 13. **Per capita GDP of the candidate countries and the convergence if the growth rate experienced so far is maintained**



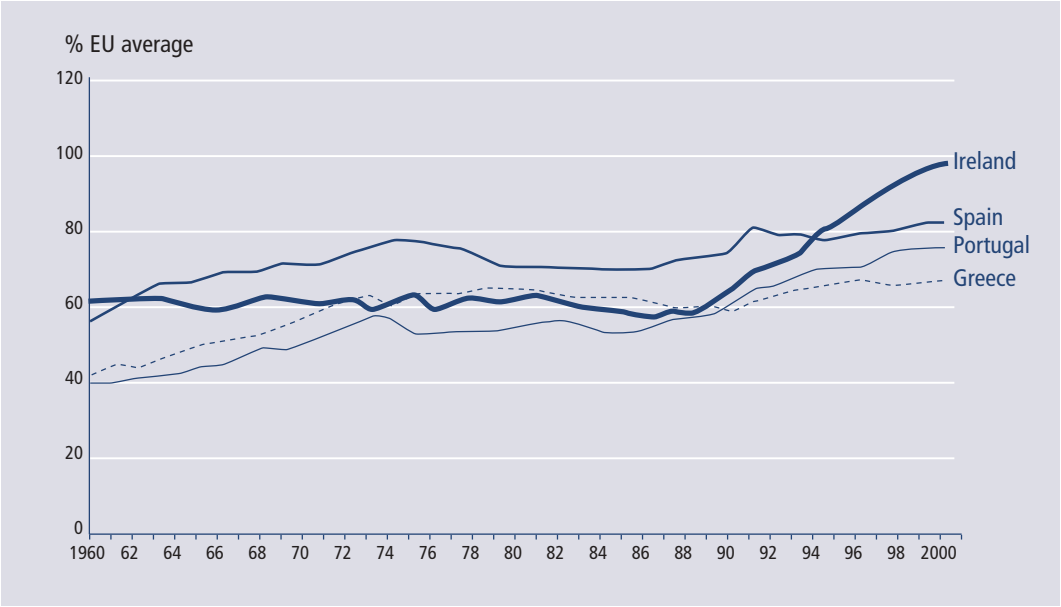
Source: *Real Convergence in Candidate Countries - Past performance and Scenarios in the Pre-accession Economic Programmes*, European Commission, DG Economic and Financial Affairs, 2001.

Such a calculation provides a realistic estimation of the enormous work Estonia must do in furthering its economy. Then again, one should keep in mind that nothing can guarantee automatic realisation of the economic growth. The actual development depends on particular Estonian companies' readiness, to face potential opportunities and risks, how purposefully they plan for their future and manage to compete in the domestic and foreign markets.

Therefore, below we will try to assess briefly the impacts of EU accession on Estonia's economic development, also paying attention to how the earlier enlargements influenced the economic development of the "peripheral countries" of the European Union.

In the past decade, investments from the European Union's cohesion and structural funds have undoubtedly played a major role in the economic success of Ireland (and Finland). However, in retrospect it is clear that this explanation alone is not sufficient. Ireland became a member of the European Union already in 1973, Spain and Portugal in 1986, Greece even earlier, in 1981. From these countries, in the 1990s only Ireland experienced an unprecedented rapid economic growth in the period of EU membership, its economy having been in a deep crisis over the entire ten-year period that preceded the boom.

Figure 14. **Convergence of the peripheral countries with the European Union's average (GDP per capita)**



Source: Frank Barry, *Economic policy, income convergence and structural change in the EU periphery*, in Henryk Kierzkowski (ed.) *From Europeanisation of the Globe to the Globalisation of Europe*, London: Palgrave-Macmillan 2002, http://www.ucd.ie/~economic/staff/barry/fdi.html.

The Irish Economic and Social Research Council stated in their report: "Ireland's economic success in the past decade was primarily due to its success in attracting foreign direct investment. There are many reasons why Ireland has become a favoured location for multinational corporations in the electronics, pharmaceutical, chemical, health care, software, teleservices and financial services sectors. Good industrial policies implemented by a very professional organisation, EU membership, an effective education system, the recent growth in the US economy, improved communications, changes in the underlying geography of the World economy, tight fiscal control, national wage agreements and an English speaking work force, are all important reasons".[70]

[70] Tom O'Connor, *Foreign Direct Investment and Indigenous Industry in Ireland: Review of Evidence*, Economic and Social Research Council, Dublin, January 2001.

The success was thus rooted in the right choice of public strategies and purposeful work towards the desired result. In a rather similar fashion to the 1980s' prolonged economic crisis in Ireland, the abrupt economic downfall caused by the loss of the eastern markets and the subsequent changes in the choice of strategy were the foundation of the economic success of Finland in the 1990s.[71]

For most member states, however, EU membership has not automatically ensured a rapid economic growth. The above two examples as well as the experiences of other countries suggest that the initial basis of the "high-salary strategy" (see Chapter 3.2) designed to lead to growth in both the country's competitive ability and the real income of the population rests on a change in the economic policies based on a wide social consensus.[72] Thus the challenge for Estonia is to break out of the one-year national budget planning cycle and develop a coherent medium- to long-term strategy of economic development.

Concurrently, the other transition societies are actively engaged in establishing a stable social and economic framework, restructuring their industries and reforming their policies. In the 1990s, a stable monetary system and liberal economic policy laid the foundations for a rapid economic growth in several countries. But for a much larger number of economies, such a policy has not given a push. Despite the efforts of the IMF, World Bank and other international organisations, South-East Asia and Russia, and also Argentina - which quite recently had been the favourite of foreign investors and regarded as the personification of a super-successful country of reforms - were hit by a severe economic crisis in the past decade.

In the November 2002 issue of The Atlantic Monthly Joseph E. Stiglitz, the 2001 Nobel Prize Laureate in Economics takes a look back at the economic policy of the United States in the 1990s which he actively helped shape in his capacities of a member of the top management of the World Bank, chairman of the President's Council of Economic Advisers and as a member of President Clinton's cabinet. Currently Professor of Economics and Finance at the University of Columbia, he is very critical: "For years we were extraordinarily lucky. ... In explaining our success of the 1990s to ourselves and the world we have largely drawn on a set of myths that desperately need debunking." The "turning around" of an economy is a long and slow process; economies change so slowly that cause and effect are not always clear.[73]

This is also true in case of Estonia - although we have made all the right moves, it does not mean that continuing in the same way will bring us any success in the future. Estonia has often, by confusing the causes and effects, completely forgotten the real sources of economic growth.

[71] Petri Rouvinen, "Finnish Experiences in Information Society", World Bank Knowledge Economy Forum, February 2002, Paris.

[72] Michael Porter, *Building Competitive Advantage: Lessons from other countries*, report at the Mediterranean Development Forum: Knowledge and Skills for Development in the Information Age, Marrakech, Morocco, May 12–17, 1997, http://www.worldbank.org/mdf/mdf1/advantge.htm.

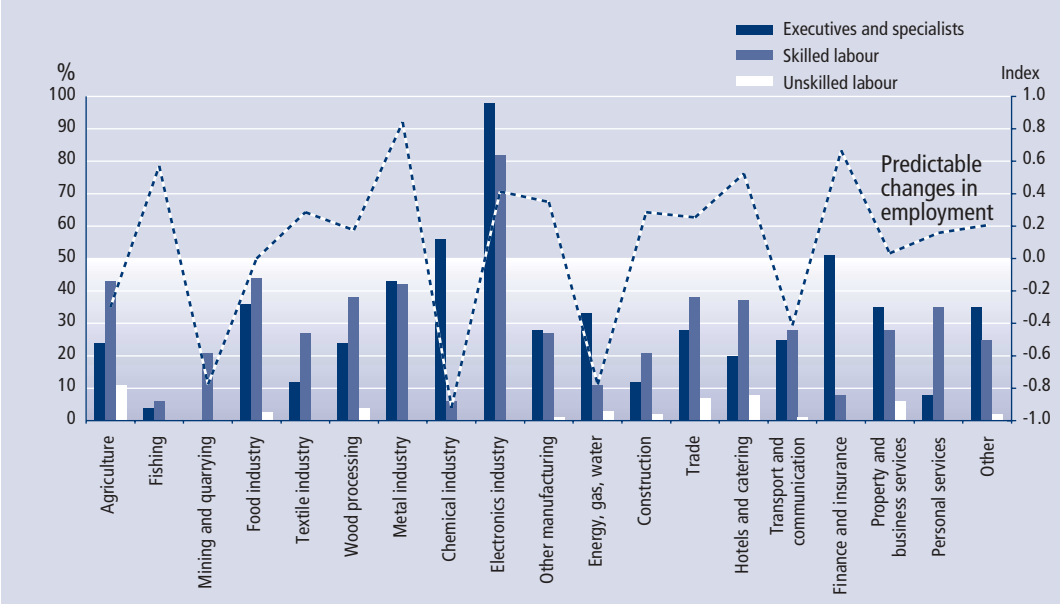
[73] Joseph Stigliz, "The Roaring Nineties", *The Atlantic Monthly*, October 2002, http://www.theatlantic.com/issues/2002/10/stiglitz.htm.

3.2 Challenges and choices in Estonian policies

The simultaneous increase in the salaries and dropping productivity growth (Figure 3, p. 11) spells out the fact that the competitiveness of the Estonian economy and enterprises is rapidly declining. This process is only enhanced by the current quality of foreign investment and the enterprises' involvement in the "cheap input" labour-intensive branches of economy.

Even if the continuation of the policies of the past decade meant that in the next few years the numeric indicators of economic growth would remain at the present rather high level, no qualitative economic improvement or increase of the competitive ability could follow. Such development is characterised by low or diminishing productivity. As a result, the economy is not capable of producing extra resources needed for solving the problems of social and regional development. The real incomes of people are "locked" at more or less the same level.

Figure 15. **Great difficulties in finding suitable employees**



Source: Ministry of Economic Affairs, *Regionaalse tööjõusituatsiooni uuring* (Research into the Regional Situation of Labour Force), October 1999.

In short, this means that Estonia is rapidly losing its competitive advantages of relatively cheap labour and, to a smaller extent, of local raw materials. Moreover, the pace at which exports increase is now slowing down, mainly due to quality reasons. Estonia does not produce enough new high-quality products or services.

Entrepreneurs perceive the strong competition in foreign markets, and lack of high- quality labour and resources necessary for product development as the main export barriers.[74] All this suggests that Estonia is coming dangerously close to the threshold of the vicious circle which is characteristic of peripheral development.[75] The problem is further aggravated by the knowledge that once locked in a circle of negative development, one cannot break out.

[74] *Eksportööride uuring 2001* (Research into Exporters), Export Agency, Ariko Marketing.

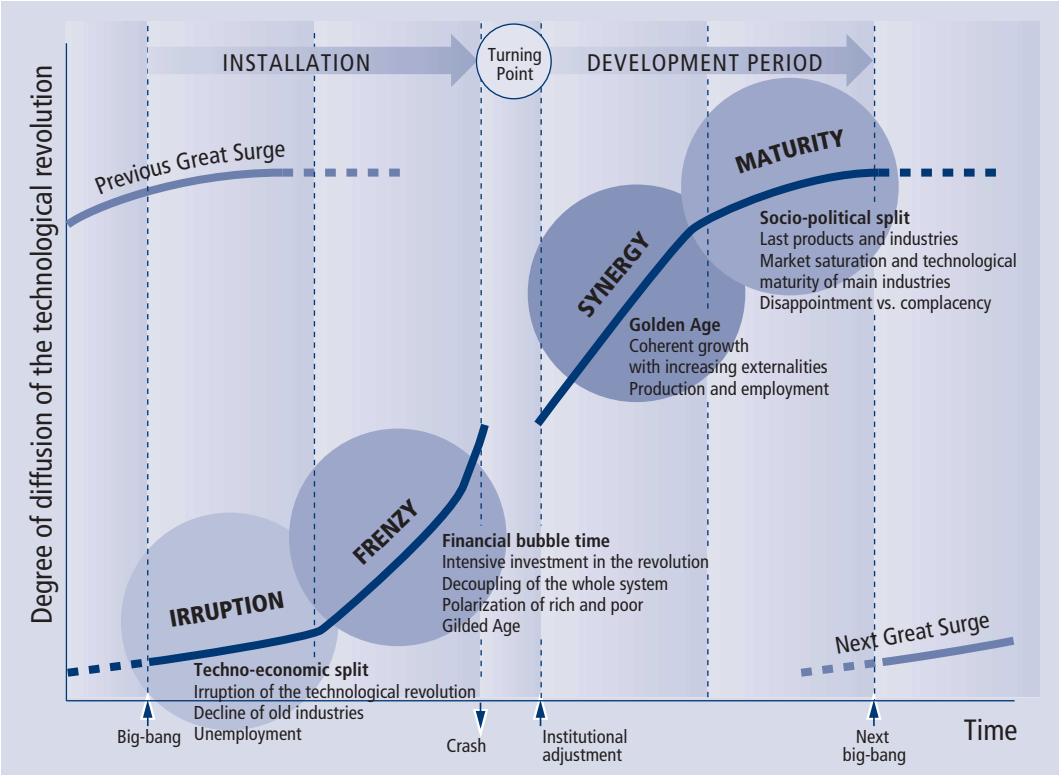
[75] Erik S. Reinert, "The Role of the State in Economic Growth", *Journal of Economic Studies*, 26, 4/5, 1999, pp. 268–326.

It is only a new trend in productivity growth that would allow one to break the vicious circle. As pointed out in the introduction, sustainable growth of productivity is possible only thanks to innovation based economic activities. This, however, requires the implementation of policies that are radically different from those currently pursued in Estonia today. Yet, this is not a choice between whether to continue the current policies or implement new ones, because continuing the current policies can have only one consequence - moving along a negative and closed circle of development and being a country of peripheral development.

Knowledge-based Estonia provides for three key areas which might lead to a substantial increase in the country's productivity. On the basis of that strategy, Estonia's R&D and innovation policies need to develop, first and foremost, information technology and information society, biomedicine and material technologies. Although *Knowledge-based Estonia* does not specify the reasons underlying this choice, the objective is to improve the competitiveness of the Estonian economy by relying on those sectors.

It can be said that in a long-term perspective no capitalist economy develops randomly or aimlessly; as a matter of fact, it develops towards gradually increasing productivity. However, this development is not smooth and linear but dynamic with sudden leaps. This is caused by an extensive use of new technology which has a wide expansion potential and triggers higher productivity, i.e., by the techno-economic paradigm.[76]

Figure 16. **Development of the techno-economic paradigm**



Source: Carlota Perez, *Technological Revolutions and Financial Capital. The Dynamics of Bubbles and Golden Ages*, 2002, Cheltenham - Northampton, MA: Edward Elgar Publishers.

[76] Carlota Perez, *Technological Revolutions and Financial Capital. The Dynamics of Bubbles and Golden Ages*, 2002, Cheltenham - Northampton, MA: Edward Elgar Perez; in Estonian see Tarmo Kalvet and Rainer Kattel, "Majandusareng, innovatsioon ja tehnoloogilis-majanduslik paradigma: väljakutse Kesk- ja Ida-Euroopa riikidele" (Economic Development, Innovation and the Techno-economic Paradigm: A Challenge to Central and East European Countries), *Riigikogu Toimetised*, 5 2002, pp. 142–148; Jürgen G. Backhaus, Leonardo Burlamaqui, Ha-Joon Chang, Wolfgang Drechsler (Chair), Jan Kregel, Erik S. Reinert, Tarmo Kalvet, Rainer Kattel. Creative Destruction Management in Central and Eastern Europe: Meeting the Challenges of the Techno-economic Paradigm Shift. Tallinn: PRAXIS, forthcoming in 2003.

As testified by economic history, these paradigms tend to last for nearly half a century,[77] starting with explosive development in narrow fields of technology, until the technology becomes so cheap and offers a multitude of different applications, essentially allowing all branches of industry to sharply increase productivity (Figure 16).

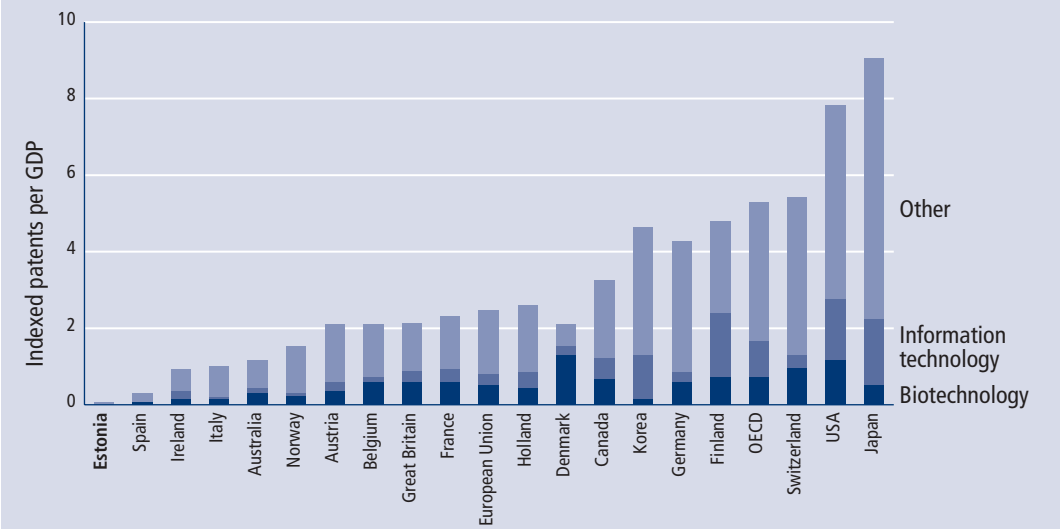
On the other hand, the rapid spread of knowledge and technology, particularly in the developed countries, means that productivity, relying on certain technologies, cannot grow endlessly, and will decrease, because of toughening competition, inversely proportionally to the spread of technology and the technology exhausts its potential. In such a situation, a new technology and a new related paradigm can generate a new rise in productivity. New technology creates asymmetric markets and distribution of knowledge. This means that R&D and innovation policies must always proceed from specific technology and its specific stage of development.

The current paradigm is based on information and communication technologies (ICT), meaning that the productivity growth is greatest in the ICT sectors, giving spillovers into other sectors via introduction of ICT and its inherent organisational and financial innovations. Bio- and nanotechnologies are very likely those that will form the broad and widespread technology of the next paradigm.

Those technologies will presumably be those which allow an abrupt or even decisive improvement in productivity now and in the decades to come. When improved productivity, based on a certain technology, expands and penetrates into other sectors, in turn raising productivity in the latter, this means a vigorous economic development.

Massive investment into those technologies in the developed industrial countries is convincingly reflected by international patent statistics (Figure 17).

Figure 17. **Intensity of patenting in the US, broken down to countries of origin**



Source: New economy: *Beyond the Hype*, OECD, Paris, 2001; Estonia: U.S. Patent Office and the authors' calculations.

[77] The ICT paradigm, which has developed very fast during the 1990s, has just passed the financial bubble time and reached turning point. Before current paradigm there were the age of 'Fordism' or mass production (1940-1990s), age of electricity and steel (1890-1940s), age of steam power and railways (1840-1890s), and industrial revolution: factory production and textiles (1780-1840s).

Today, innovation policies towards ICT and biotechnology are radically different, because ICT has reached a phase where the breakthrough development of pure technology is coming to the end but the use of ICT for economic purposes is only beginning. This means that the competitive advantage brought by the development of ICT as a technology will be disappearing, supplanted by a competitive advantage and increased productivity brought by the use of ICT as an economic activity, and not only in the ICT sector. Biotechnology is still in the technological development phase yielding an economic effect.[78] Innovation policy has always to be divided into policies centred on different technologies and economic clusters.[79]

[78] Carlota Perez, *Technological Revolutions and Financial Capital*; Carlota Perez's presentation, which also discusses Estonia, at the seminar *How are ICT and Biotechnology Related? Policy Implications for Estonia*, is available at www.praxis.ee/innovation/workshop/.

[79] Innovative Clusters: Drivers of National Innovation Systems, OECD, Paris 2001; Michael E. Porter, The Competitive Advantage of Nations, London: Macmillan, 1990.

3.3 Knowledge-based economy

Knowledge-based Estonia is certainly not a unique political document in the world. Many developing and developed countries have tried to solve and are currently tackling similar problems to those pointed out in it. Everyone knows the progress of Asian "tigers" in the field of high technology over the last decades, and the success of Finland and Ireland in the 1990s. However, there is probably an equal number of failures. For example Brazil, which at the beginning of the 1990s set much the same goals as Estonia is setting at present: a much greater and broader co-operation of science and industry, and a substantial increase in the share of private enterprise in the field of R&D. The measures applied to attain these ends were also very similar to those either already applied or planned in Estonia: (partial) financing of co-operation projects of science and enterprise; support to enterprises' product development, direct aid (grants) to projects, etc. Today this role is played by the Estonian Technology Agency (ESTAG).

However, these measures have proved by now to be quite ineffective in Brazil (in some cases even after 20 years of application), and most of them have been removed. There are certainly many specific reasons for this, including a weak quality and administrative control over the measures. The most important reason for the failure, however, is that these measures were not able to alleviate the greatest problem that goes hand in hand with R&D and innovation - risk. Business R&D is *a priori* related to a great risk of failure. The measures taken in Brazil did not take account of the specificity of the country and its economy (markets are dominated by single large-scale companies, i.e. the market penetration barriers are very high for new companies), and the funds directed to R&D originated from the ordinary market (that is, even loans guaranteed by the government were related to market interests, making these loans as well very expensive). In summary, the measures did not consider the existing institutional framework of the particular country and economy, and staked on copied or incomplete solutions, the share and effect of which, however, were too small to shift the existing framework in the desired direction.[80]

A similar process has occurred during the last decade in the development of the ICT industries in Europe and the USA. According to a widely spread belief, ICT is the main technology today that can lead to a greater productivity growth than anything else. While the development of the US economy proves it in figures, that of Europe does not (yet).[81] The reasons again mainly lie in the broader institutional framework. On the one hand, the financing and support of European R&D has been based on an overly linear understanding of innovation, according to which the money invested in R&D is hoped to be recouped, on an one-to-one basis, by innovative enterprise in the same or slowly changing enterprise structure.[82] This is what that "European paradox" means: the public sector's research competence in Europe is strong, while the scope of R&D in the enterprise sector is relatively smaller.[83] On the other hand, a large proportion of enterprise lies within the institutional and legal "welfare framework", which was once created to protect domestic markets and provide protection against sudden and rapid changes in the labour market.[84] This is supplemented by a powerful and quick "Americanisation" of financial markets, i.e. a movement toward capital markets, which, however, does not find enterprises or potential enterprises in the market, as the labour market and the related education system are rather rigid, hence amplifying the operating risks of every new enterprise, as every new enterprise faces toughening competition where the ability to change is a key factor. In other words, the institutional framework favours traditional areas of activity, while the potential of new ones, such as ICT, is at first put into use in the very same (traditional) areas.

[80] Lea Velho and Tirso W. Saenz, "R&D in the Public and Private Sector in Brazil: Complements or Substitutes?", The United Nations University, Institute for New Technologies, Discussion Paper series, July, 2002.

[81] Focco Vijselaar and Ronald Albers, "New Technologies and Productivity Growth in the Euro Area", European Central Bank, Working paper No. 122, February 2002; Bart van Ark, "The Renewal of the Old Economy: An International Comparative Perspective", OECD STI Working Papers, No 5, 2001.

[82] Joyce Tait and Robin Williams, "Policy Approaches to Research and Development: Foresight, Framework and Competitiveness", *Science and Public Policy*, 26(2) April 1999, pp. 101–112.

[83] This paradox has been empirically confirmed to exist for the ICT sector as well. See e.g. Robert J.W. Tijssen, and Erik van Wijk. In Search of the European Paradox: an International Comparison of Europe's Scientific Performance and Knowledge Flows in Information and Communication Technologies Research. Research Policy, 28, 1999, pp. 519–543.

[84] Ronald Dore, *Stock Market Capitalism. Welfare Capitalism*, 2000, Oxford, New York: Oxford University Press.

The challenge faced by Europe has many different facets, the most important of which is perhaps reforming the labour market, while creating additional motivations for enterprise and reducing risks related to innovation. This has brought about extensive reforms of taxation systems, as tax incentives can reduce the risks of enterprises most effectively and quickly.[85]

Michael E. Porter, Professor of Harvard University, also demonstrates a clear relation between competitive power at the national and enterprise levels.[86] He claims that enterprises and branches of the economy are competitive when the national environment and government policy facilitate profit making and innovative efforts of enterprises. The competitiveness of enterprises depends on production factors, demand, strategic choices and co-operation (clustering)[87]. Government policies, luck, and the international business environment are all important shapers of the operating environment of enterprises.

[85] *Corporation Tax and Innovation*, European Commission, Innovation Papers No 19, 2002.

[86] Michael E. Porter, *The Competitive Advantage of Nations*, London: Macmillan, 1990.

[87] Michael E. Porter, Global Competitiveness Report 2002-2003, World Economic Forum, Chapter 1.2

3.4 Development of the ICT paradigm in Estonia

Like other countries, in the 1990s Estonia experienced explosive development of information and communication technology. In recent years, Estonia has often been pointed out in this context as a country that has quickly adopted new technologies and experiments with new ICT solutions.[88] Indeed, we have been the leaders among the Central and East European Countries by the penetration rate of Internet connections and cell phones. However, assessment of the development of Estonia should neither be based on superficial indicators only or blindly associate such indicators with economic development or sustainability.[89]

An in-depth analysis of the innovation system of Estonia's ICT sector draws attention to the following important factors.[90]

The primary shaper of development in the Estonian ICT sector is subcontracting. External orders are of paramount importance to Estonia's ICT sector and the lion's share of the subcontracts is oriented towards Finland and Sweden (84% of the export market of ICT products of Estonia). According to experts, AS Elcoteq Tallinn provides 83% of the entire ICT export of Estonia and 96% of the export of telecommunication equipment. Therefore, the view of Estonia as part of the Scandinavian ICT cluster holds ground. The impact of the Scandinavian countries is two-fold: on the one hand, it has promoted the launching of new technologies and, thanks to subcontracts, has provided Estonian companies with a steady income; on the other hand, it has conduced to catalepsy as the country's ICT industry is encased in activities of small added value.

As one of the most important problems of the ICT sector of Estonia, 56% of Estonian ICT companies lack specialists in specific products or technologies, 39% are looking for project managers and sales personnel.91 Only 10% are currently in need of R&D employees, while 20% assume that the need for additional R&D personnel will surface only in a longer-term perspective. However, the existing data and analysis indicate a discrepancy between the skills provided by training courses and the actual needs of the industrial sector.

The disparity between Estonia's proud claims about being a successful IT nation and the actual situation is further confirmed by the fact that in 2000 public sector donors allocated approximately 11 million kroons for R&D in the field of ICT, that is, approximately 5% of the total funding allocated by the Estonian public sector for R&D activity. The extreme fragmentation of the public financing of R&D, a large number of small-scale projects and relatively weak competition testify to the vulnerability of the present financing system. The existing system does not facilitate launching of new, high-risk and potentially highly profitable R&D initiatives.

Estonian ICT companies do not feel compelled to elaborate modern solutions; they mostly desire to quickly copy novel products created elsewhere. Therefore, they fail to see the importance of long-term strategic planning. For example, 50% of the ICT companies in the sample admitted that their so-called "strategic" business plans either covered only one year or were missing altogether. At the same time, R&D activities require typically at least a three-year planning and implementation cycle plus the time necessary for the product to enter the market.

The national innovation system of the ICT sector is characterised by rather limited cooperation between the academic and business communities, while only a few institutions are engaged in creation of high added value. Only 35% of the ICT enterprises of Estonia admitted that they knew something about the existing scientific research establishments; only 9% of the companies had ever used professional assistance from research institutions. More than half of the poll respondents pointed out the overly academic approach of the universities and R&D institutions as the reason for their limited cooperation.

Thus we see that the ICT sector of Estonia is in fact a reflection of the country's other industrial and economic sectors, indicating that in Estonia the economic activity and investment in the field of R&D

88 McConnell International, *Ready? Net. Go! Partnerships Leading the Global Economy*, 2001, http://www.mcconnellinternational.com/ereadiness.

89 Tarmo Kalvet. Analysis of the Estonian ICT Sector Innovation System. ICT, Innovations and Innovation policy: The Case of Estonia, 2002, http://www.esis.ee/eVikings/

90 See Tarmo Kalvet, Tarmo Pihl and Marek Tiits, Analysis of the Estonian ICT Sector Innovation System. Executive Summary, 2002, Tartu: SA Archimedes, http://www.esis.ee/eVikings/

91 In May 2001, a poll was taken among 99 major Estonian ICT entreprises.

are excessively risky. But this means that the existing ICT sector is incapable of promoting a vigorous productivity growth either in itself or other economic sectors. The reason is that the companies' activity is not sufficiently research-intensive.

This is confirmed by the recently made survey Innovation in Estonian Enterprises 1998-2000. Many Estonian entrepreneurs see the renewal of the technological foundation as innovation, which in fact does entail productivity growth; however, this can only be temporary and unsustainable since the share of high technology is nominal in the renewal of the technological foundation.[92]

This means that, on the other hand, the current development today offers an opportunity to invest in other sectors of higher profitability; however, as follows from the survey, their productivity is decreasing at the same time (see also Chapters 2.3-2.4). Entrepreneurs lack the internal need and pressure to look for investments carrying a higher risk as would be the R&D in case of liaison with universities. At the same time, the major part of the industry of Estonia and the other Central and Eastern European countries as well is low-tech by nature, causing the aspiration to raise the private sector's expenditure on R&D in Estonia to the same level with that of the developed countries to be unachievable. The only possibility would be total industrial restructuring, including movement towards the launching of high technology within the low technology branches.

The problem is also largely in the fact that both the wider public as well as most entrepreneurs still believe that it is only large companies that can have a competitive edge, because they can thanks to economies of scale, conquer larger market shares and new markets. Indeed, it seems to be correct and logical to assume that it would be ever more difficult to force one's way through the increasingly globalising and competitive world. However, this opinion is largely premature and also incorrect: a knowledge-based economy requires ability for fast change, flexible re-structuring of production, and a labour market capable of supporting such changes.

A good example is the vigorous development of the Taiwanese computer sector, although it nowadays comprises mostly small enterprises. Supported by the government's policies (tax allowances), Taiwanese enterprises cooperate actively, thereby not only expanding the spectrum of knowledge, but also accelerating its spread and application to other sectors, bringing about their development. Therefore, Taiwan has managed to create a competitive advantage, using its existing business structure and directing and motivating it by a clever policy.[93]

[92] Silja Kurik, Rünno Lumiste, Erik Terk and Aavo Heinlo, *Innovation in Estonian Enterprises 1998–2000,* Enterprise Estonia, 2002.

[93] Dieter Ernst, "What Permits Small Firms to Compete in High-Tech Industries? Inter-Organizational Knowledge Creation in the Taiwanese Computer Industry", DRUID Working Paper No. 98-3, February 1998.

4. Knowledge-based economic policy

4.1 The role of the State in shaping a knowledge-based Estonia

We have demonstrated in the previous chapters that Estonia's rapid economic growth in the last decade was mainly founded on technological innovation concurrent with rapid privatisation and inflow of foreign investment, which was also supported by the availability of appropriately trained labour. Although a stable economic environment, a firm currency and openness have been the essential prerequisites for development, the development itself is still due to productivity growth in the economy.

Although the strategy *Knowledge-based Estonia*, probably one of the most essential documents in the area of economic policy, was approved by *Riigikogu* on 6 December 2001, a broader understanding of this document in the society, continues to be poor - among politicians, entrepreneurs, officials and scientists. *Knowledge-based Estonia* is seen as one of those several dozens of strategies in other areas aimed at ensuring increased budgetary financing for R&D activities rather than the groundwork for a fundamentally new quality in education, business and other areas.

So far the Estonian economic policy thinking has mainly focused on perfect market competition in which all market participants have uniform access to production inputs, and the main means of profiting is through cost effectiveness. Therefore, if Estonia is willing to implement the strategy approved by *Riigikogu* and the Government, it should execute an abrupt about-face from the current policy, as only a substantively new economic policy can bring the country closer to a knowledge-based economy and society.

In the autumn of 2001 the Research and Development Council came to the following conclusion: "… along with the maintenance of a stable macro-economic environment, the increase of labour productivity must be one of the basic foundations of Estonia's economic policy. To this end, innovation policy, which is explicitly directed at promotion of development, is central through the spread and effective implementation of novel products, services and processes in markets as well as in the private and public sector".[94]

Even today, in the economic policy of developed countries the state plays an important role in the creation of such a socio-economic or institutional environment that would favour enhanced quality of business activity and would help make technological development virtually the engine of economic development. The development of business activity towards intensive know-how creates imperfect market competition in which new hardly imitable know-how and technologies provide companies with additional competitive advantages, thereby supporting the growth of productivity and real income in the country.[95]

In view of the aforesaid, it is not surprising that the last Progress Report, one of the most important pre-accession tasks assigned to Estonia by the European Commission in order to elaborate and start the implementation of a comprehensive industrial policy, began as follows: „There is still a need to complete the development of a comprehensive industrial policy and to define and implement specific measures in this framework. Estonia should continue its efforts and set clear priorities in collaboration with the business community, the financial sector and other relevant stakeholders".[96]

Moreover, even if the analysis of Estonia's economy provided by this review reflects reality to a minimal degree, the current state financing of individual innovation projects is only of nominal use in ensuring the country's future economic success. The economic development of Estonia can be successful provided that the entire socio-economic framework of Estonia - its innovation system[97] (Figure 18) - proves to be in line with the main characteristics of a knowledge-based economy.

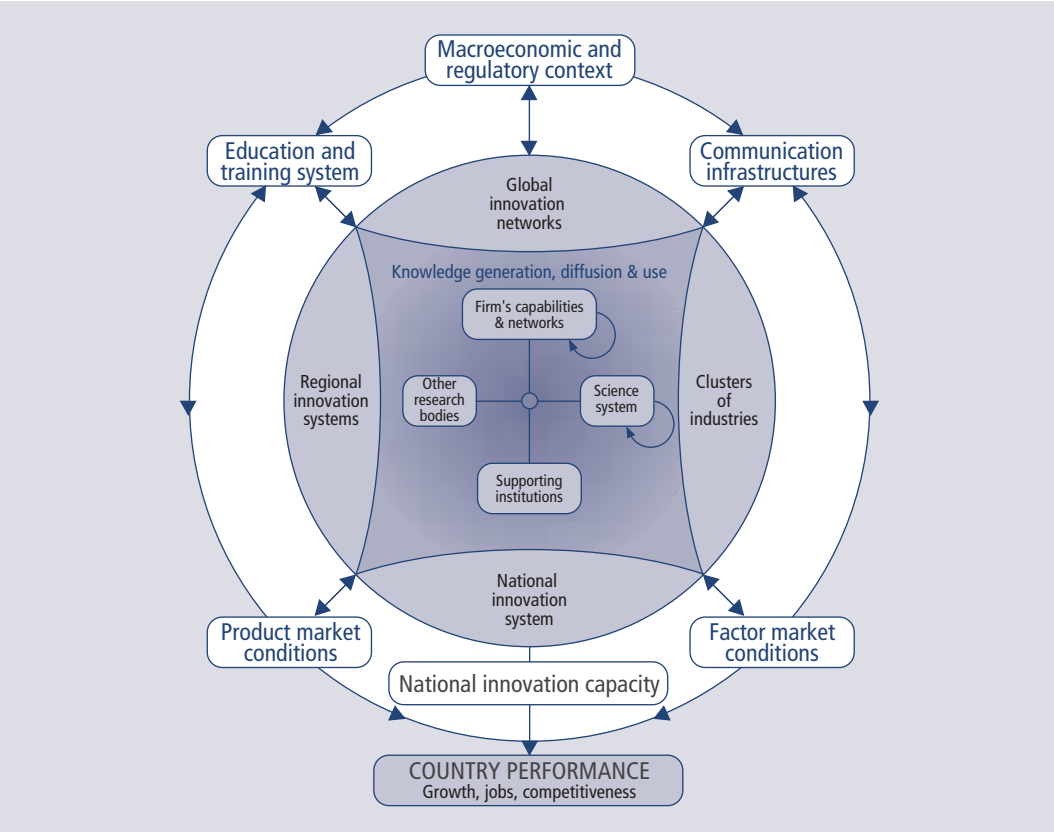
[94] *Eesti teadus- ja Arendustegevuse ülevaade 2001-2002* (Estonia's Review of Research and Development Activity 2001–2002), Tallinn 2001; This generally accepted definition of innovation policy arises from the popular approach: Bengt-Åke Lundvall and Susana Borrás, *The Globalising Learning Economy: Implications for Innovation Policy*. Luxembourg: Office for Official Publications of the European Communities, 1999.

[95] Erik S. Reinert, "The Role of the State in Economic Growth", *Journal of Economic Studies*, 26, 4/5, 1999, pp. 268-326.

[96] Commission of European Communities, 2002 Regular report on Estonia's progress towards accession, COM(2002) 700 final, http://europa.eu.int/comm/enlargement/report2002/ee_en.pdf.

[97] An innovation system is a network of institutions, which includes both public and private institutions, the synergy of which creates conditions to the spread and economic implementation of know-how. See Cristopher Freeman, *Technology and Economic Performance: Lessons from Japan*. London, Pinter, 1987; Bengt-Åke Lundvall, *National Systems of Innovation: towards a theory of innovation and interactive learning*. New York, A Cassell Imprint, 1995.

Figure 18. **National innovation system**



Source: *Managing National Innovation Systems*, OECD, Paris 1999, p. 23.

In the absence thereof, the result is often the opposite. As shown by European experience, many knowledge-based small enterprises and spin-offs are unable to achieve a critical mass because of an unfavourable environment; they have a short lifetime and weak business plans, they create little know-how and even fewer new products, thus having very little impact on both the development of global technology and innovation in the local economic environment.

Direct state support to technological development, i.e. support to research and development activity, can only be effective if it involves a concurrent institutional change and development. These measures must not be limited to the creation of councils and committees or the arrangement of „awareness raising workshops" for companies; this must instead trigger changes in real life.

This does not mean reinvention of the wheel. Since its earliest times in the city-states of Italy, capitalism has involved and needed even more institutions allowing the economy to operate and progress. Today we consider it self-evident that such institutions include, for example, limited liability companies, central banks, bankruptcy legislation, protection of intellectual property, a patent system, etc. In history, we can find many examples of states that have concentrated on the creation of novel know-how and innovation and have thereby ensured economic development and improved quality of life, avoiding the closed circle of negative development (see also Chapter 3.2).[98]

[98] See, for example, Erik S. Reinert, "The Role of the State in Economic Growth", *Journal of Economic Studies*, 26, 4/5, 1999, pp. 268-326.

The government is therefore obliged to change, reform and readjust institutions and environment (legislation, the educational and taxation system, etc.) and to demonstrate innovation in policy-making. This is the government's responsibility, since it is only the state/government that can do it, and only the government has the necessary legitimacy - irrespective of whether we proceed, in order to prove this assertion, from the classic argument of market failure or from the understanding pursuant to which the government must ensure a favourable environment for sustainable economic growth. Doing nothing can only lead to retardation of economic development and a rapid reduction in competitiveness.

Consequently, the system of innovation must direct the interests of entrepreneurs and scientists in the procurement and implementation of novel know-how, thereby considering the specific environment and market, and creating motivation in accordance with the stage of technological development of enterprises. It follows from here that the second aspect of the government's role in technological development consists in the direct and indirect support and financing of the development of novel technologies for increasing productivity through both basic and applied research (direct support) and the creation of technology stock and/or technology programmes focusing on large-scale and specific technology (indirect support).

4.2 Possibility to emulate Ireland's recent economic success?

Analysing the foundations of Estonia's current economic growth in the preceding chapters, we found that foreign investment has played a key role not only in stabilising the foreign trade balance, but also, and even more significantly, in technological revival, thereby serving as the main trigger of Estonia's overall economic growth.

Judging by the productivity indicators of the Estonian economy, our catching-up process is still far from being completed. Therefore, the inflow of technology which is superior to that used presently and its meaningful application continues to perform an essential role in ensuring the country's economic progress.

If we examine the foundations of Ireland's rapid economic progress, we see that, similarly to Estonia, foreign investment played a crucial role in it. In the 1990s, it was foreign direct investment that first triggered the modernisation-related structural changes in Ireland's economy and thereafter the out-performance of the average income level of the United Kingdom. Hence the main changes took place in the structure of industrial production, which became more similar to that of the "core states", the share of modern production in total exports increased, and the economy became more research and development intensive.[99]

Mission orientation upon the attraction of foreign investment to the country is well illustrated by the well-implemented activity logic that, in attracting foreign investment, Ireland was prepared to support (in monetary terms) good projects in all internationally tradable economic sectors, although in different amounts. The Industrial Development Agency of Ireland was increasingly active while considering target markets upon project selection. Areas with a presumable market growth potential were given preference. First, the most rapidly growing market niches were identified in which projects are internationally mobile and in which Ireland could offer a competitive environment. Then, viable enterprises in these areas were identified and contacted by inviting them to Ireland to examine the conditions offered.[100]

Many researchers hold the opinion that the presence in a country of a vigorous environment of research and development activity is a prerequisite for the existence of high technology industry.[101] At the same time, Ireland's experience confirms that under certain conditions this relationship may be contrary. In terms of its share of business research and development activity as a proportion of the GDP, Ireland has caught up with several other small European countries.

Most of the said investment was performed by foreign enterprises and enterprises based on foreign capital.[102] In the 1980s and 1990s, investments by foreign enterprises continuously represented over 60% of all business investments in research and development. This is a vivid demonstration of the fact that Ireland's success in attracting foreign investment entailed improvement of the R&D climate, rather than vice versa.[103]

The analysis of the transition and developing countries conducted by UNIDO shows that only a few of them have managed to repeat Ireland's performance: to combine their reliance on foreign direct investment with a strong industrial policy while dealing purposefully with the areas in which they desire to enter the market, and developing skills necessary to that end. Most of the countries have applied far more passive foreign investment policies, benefiting from a sound macro-economic equilibrium, business support, attractive location and good luck. The less successful developing economies - and there are many - have not managed to implement any of these strategies properly.[104]

The analysis of the foreign direct investment flows received by the Central and Eastern European countries shows that they differ from those sought by Ireland in terms of export orientation, technology level, and country of origin.

[99] Frank Barry, *EU Accession and FDI flows to CEE countries: Lessons from the Irish experience*, University College Dublin, February 2002.

[100] Tom O'Connor, *Foreign Direct Investment and Indigenous Industry in Ireland: Review of Evidence*, January 2001, 10, http://www.ssees.ac.uk/ireland.pdf.

[101] See, for example, K.H. Midelfart-Knarvik, H.G. Overman, S.J. Redding and A.J. Venables, *The Location of European Industry*, Economic Papers No. 142, ECOFIN, European Commission, 2000.

[102] Frank Barry, John Bradley and Eoin O'Malley, "Indigenous and Foreign Industry: Characteristics and Performance", Chapter 3 in *Understanding Ireland's Economic Growth* (edited, and with an introduction, by Frank Barry), London, Macmillan Press, 1999.

[103] Frank Barry, *Economic policy, income convergence and structural change in the EU periphery*, University College Dublin, 2002

[104] *UNIDO Industrial Development Report 2002/2003*, http://www.unido.org/idr/.

Foreign investment in Central and Eastern Europe is motivated by market seeking rather than being an aspiration to integrate the present candidate countries into the European Union's production networks.[105]

Almost 68% of foreign investment in Central and Eastern Europe comes from the European Union. The United States' share has been unsubstantial. At the same time, more than one half of the employment in foreign-owned enterprises in Ireland and more than 70% of output comes from enterprises with US-owned capital.

In terms of technological level, the foreign direct investment received by the Central and Eastern European countries is more similar to the relatively low-tech Spain and Portugal than to the high-tech foreign investment sought by Ireland.

The foreign investment policy has been quite different in the Central and Eastern European countries. True enough, the taxation systems and conditions also differ. The system applied in Hungary has been the most extensive. Its similarity to the "Irish model" is also reflected by the large share of business investment in the research and development activity of the international corporations based in Hungary (Table 9). The Czech Republic has launched similar and fairly attractive support systems, as has Slovenia, which has received relatively less foreign direct investment compared to the other candidate countries (Table 28, p. 72).

Table 9. **Share of branches of foreign enterprises in all business investments in R&D (%)**

	1993	1994	1995	1996	1997	1998	1999
Spain			26.8		35.7		32.8
Holland					20.6	21.8	
Ireland	71.0		64.6		65.6		
UK		28.0	29.2	30.1	32.5	30.1	31.2
Japan	0.9	1.5	1.4	0.9	1.3	1.7	
Greece	6.5		3.8	3.4	3.6		
Portugal							18.0
France		14.2	17.1	16.7		16.4	
Sweden	14.7	10.4	18.4	18.7	15.9	17.5	
Finland					13.3	13.2	14.9
Czech Republic					1.3	2.7	6.4
Hungary		22.6	21.8	44.4	65.3	78.5	
USA	12.1	13.0	13.3	12.4	12.2	14.9	

Source: *World Investment Report 2002: Transnational Corporations and Export Competitiveness*, UNCTAD, New York and Geneva 2002, p. 19.

So far, the predominant stimulus of Central and Eastern Europe has been its cheap labour. This is especially the case for greenfield investment. In this respect, the enterprises privatised to foreign capital may be different, since they often retain connections to local suppliers and market share. The branches integrated into the local economy are also less mobile, and therefore have a more certain future than those that are only integrated into the global network. The difference between these two enterprise types is, however, disappearing. Both must become more technology intensive in order to compensate for the diminishing advantages of cheap labour.[106]

[105] D. Holland, M. Sass, V. Benacek and M. Gronicki, "The Determinants and Impact of FDI in Central and Eastern Europe: A Comparison of Survey and Econometric Evidence", *Transnational Corporations*, 2000, 9, 3, pp. 163-212; H.P. Lankes, A. Venables, "FDI in economic transition: the changing pattern of investments", *Economics of Transition*, 1996, 4, 2, pp. 331-347.

[106] Gábor Hunya, *International Competitiveness Impacts of FDI in CEEC. Background Paper for Special Session III on FDI and the restructuring of transition and emergining economies*, UN Economic Commission for Europe, December 2000; D. Holland, M. Sass, V. Benacek and M. Gronicki, "The Determinants and Impact of FDI in Central and Eastern Europe: A Comparison of Survey and Econometric Evidence", *Transnational Corporations*, 2000, 9, 3, pp. 163-212; H.P. Lankes, A. Venables, "FDI in economic transition: the changing pattern of investments", *Economics of Transition*, 1996, 4, 2, pp. 331-347.

It appears from the above said that the increase in the competitiveness of Estonia's economy presupposes a far "deeper" integration into global research and development, and production networks, while gradually renewing the technological capability and starting to perform tasks that create more added value.[107]

The market for technology is global. At first sight, it may seem that all enterprises can reach the same level by purchasing and developing new solutions, increasing the effectiveness of their operations and reducing their operating costs. However, technology is not available in a free market where all newcomers automatically have equal opportunities. This is partly due to the tacit knowledge and skills which are not formalised and exist only in people's heads, but also because of the intellectual property and market protection instruments (patents, etc).

In today's globalised world, multinational corporations provide 80% of private sector research and development expenditures, and they produce and control the majority of the world's high-tech solutions.108

Therefore, compatibility with foreign technologies and access to markets is now just as vitally important in the globalised world as before. In knowledge intensive sectors, the main way to penetrate global markets and to obtain access to new technologies and know-how is by switching into the global value chains and gradually increasing the quality of one's own activity.[109]

Ireland's experience suggests that all elements of a public policy mosaic have to be in place if success in this process is sought. For example, the low corporate tax, which has been an important element of the Irish strategy, is particularly useful for those enterprises that can shift profits between different locations via transfer pricing. Such enterprises are likely to operate in research and development activity and/or advertising intensive sectors, in which it is difficult to determine fair prices.

In Ireland, foreign investment and the clear strategic choice to increase the quality of economic activity have played a key role. Even if we consider EU membership to be one factor that has favoured the attraction to Ireland of higher quality foreign investment, the essence of that success has nevertheless been the government's activity in the promotion of research and development, and the attraction of functions related to the head office and the support of education. In turn, all this has an impact on the specialisation assigned to branches: either to be based on technology or low-cost labour.

A valuable lesson to be learnt from the Irish experience consists in the following: even though it is possible to use foreign sources for modernising one's industry, it will be necessary to raise one's domestic industrial capacity in order to ensure successful and sustainable economic development. In Ireland, the specialisation of foreign enterprises in research and development intensive sectors has increased investment in research and development activity. At the same time, foreign companies have evidently not transferred the most valuable part of their research and development activity to Ireland, nor have famous high-tech companies such as Intel and Dell patented any solutions created in Ireland.[110] Returning to the examination of the competitiveness of the country's indigenous industry, we can see that while Ireland's per capita patent performance compares favourably with that of New Zealand, other countries of a comparable size, such as Finland, Israel and Taiwan, have nonetheless patented considerably more.

On the one hand, such activity of multinational enterprises is influenced by the activity strategy on the global market, in which it is attempted to keep all strategic functions possibly closer to the head office. This behaviour is, however, more significantly related to the availability of high quality human labour in the labour market.

[107] Slavo Radoševic, *Restructuring and Reintegration of Science and Technology Systems in Economies in Transition, Final Report of the TSER Project*. Contract No: SOE1-CT95-1008, January 1999

[108] John H. Dunning, *Multinational Enterprises and the Global Economy*. Workingham, England and Reading, Massachusetts, Addison Wesley, 1993, p. 290

[109] *UNIDO Industrial Development Report 2002-2003*, chapter 6.

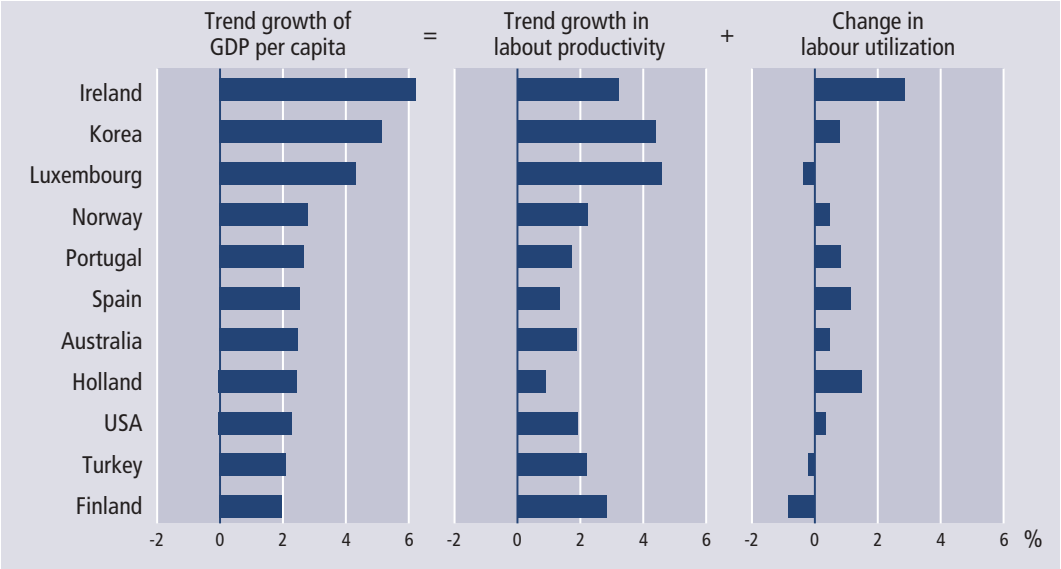
[110] Mary O'Sullivan, *The Sustainability of Industrial Development in Ireland*, Regional Studies, 34, 3, 2000, pp. 277-290.

4.3 Human resources

The 19th century and the first half of the 20th century led to the creation of versatile social welfare institutions such as accident at work insurance, pensions, health and unemployment insurances. After World War II, an active labour market policy was added, especially in the Scandinavian countries. These changes are not mere "socialism" designed to mitigate the negative facets and problems of economic (technological) development, as they may seem at first sight.

Active labour market policies ensure effective use of labour and provide flexibility in a rapidly developing and changing world, thereby being one of the most important factors in the spread of technological development and its innovative impact on economy. Disregarding this can easily provide an opposite result. Structural unemployment is very expensive, not only because of unemployment payments, but even more so because of the wasted and unused resources (Figure 19). Overall, this specifically impedes the development of new industrial sectors, since there is a lack of qualified labour.

Figure 19. **Changes in labour utilisation contribute to trend growth in per capita GDP**[111]



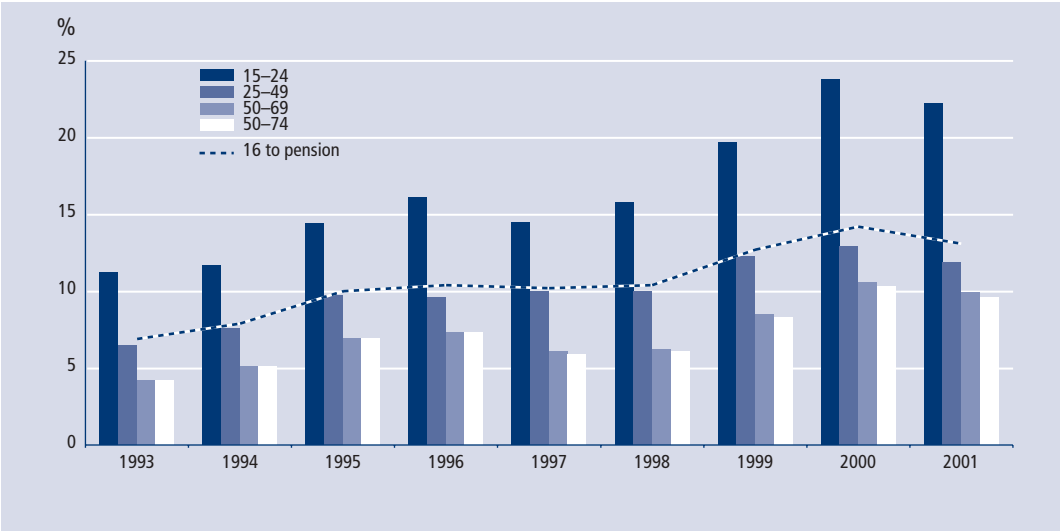
Source: *New Economy. Beyond the Hype, The OECD Growth Project*, OECD, Paris 2001, p.18.

The lack and low quality of human resources at all educational levels has become one of the main problems in Estonia. This problem is illustrated by increasing structural unemployment. One especially troublesome problem is unemployment among young people under 24 years of age, this age group having the highest unemployment rate today (Figure 20). This unequivocally points to the weakness of the education system, which is also confirmed by the repeated pronouncements of enterprises regarding the lack of qualified labour[112] (Figure 15, p. 19). In the medium term, the continuation of such a trend along with a relative increase in the number of pensioners would lead Estonia into an extremely complicated economic situation.

[111] The graph shows the breakdown of trend growth in GDP per capita in the trends in labour utilisation and GDP per person employed.

[112] Janno Järve, *Tööjõukulude mõju tööjõu nõudlusele Eesti tööstusettevõtetes* (Impact of Labour Costs on the Demand for Labour in Estonian Industrial Enterprises), PRAXIS, Poliitikanalüüs, 1, 2002; Tarmo Kalvet, Tarmo Pihl and Marek Tiits, Analysis of the Estonian ICT Sector Innovation System. Executive Summary, 2002, Tartu: SA Archimedes; PW Partners, *Eesti puidu- ja mööblitööstuse sektoriuuring* (Sectoral Research of the Estonian Timber and Furniture Industries), 1999, Tallinn; PW Partners, *Eesti metalli-, masina- ja aparaaditööstuse sektoriuuring* (Sectoral Research of the Estonian Metal, Machine and Appliances Industries), 1999, Tallinn.

Figure 20. **Unemployment in Estonia broken down to age groups**



Source: Statistical Office of Estonia, October 2002.

The prerequisite for the emergence of a knowledge-based economy and the operation of the innovation system is trust in the educational and scientific substructure, which is a distributed resource serving as a precondition for the development of economy and society.[113] Hence the role of the state is to create the environment that would motivate all members of society to learn, study, obtain new knowledge and implement it as effectively as possible in their everyday activities. Not every new thought or lab invention can reach the market, and it need not become an economically meaningful product, service or business process, i.e., an innovation. However, in the course of scientific research the knowledge base necessary for innovation will be extended, and additional human resources will be created.

The strategy *Knowledge-based Estonia* sets as an objective to increase investment in research and development up to 1.5% of the GDP by the year 2006. The supplementary investments made by the public sector should bring about an increase in private sector investment. Concurrently, the European Union has established that the level of R&D investment must reach 3% of the GDP by the year 2010. Two thirds of the amount involved ought to be contributed by the private sector.

Local technological efforts characterised by business research and development activity appear to be one of the most important remedies for the efficiency of industrial performance. This is the case in both industrialised and developing countries. Foreign direct investment accompanied by global production systems has become the main guarantee of industrial competitiveness. Skills and infrastructure in the broadest sense are thus the main driving forces.[114]

How can this be achieved? The answer to this question lies in the understanding that economic development is a process in which entrepreneurs are continuously looking for new knowledge and technologies, and also renewing their competitive advantages and strategies in line with the development of market competition. Innovation is generated by the interest of an entrepreneur in exploiting unexpected occurrences, to use the incongruities of existing solutions, needs arising from organisational processes, changes in an industry or market or new knowledge in order to improve the competitive advantages of his or her enterprise.[115]

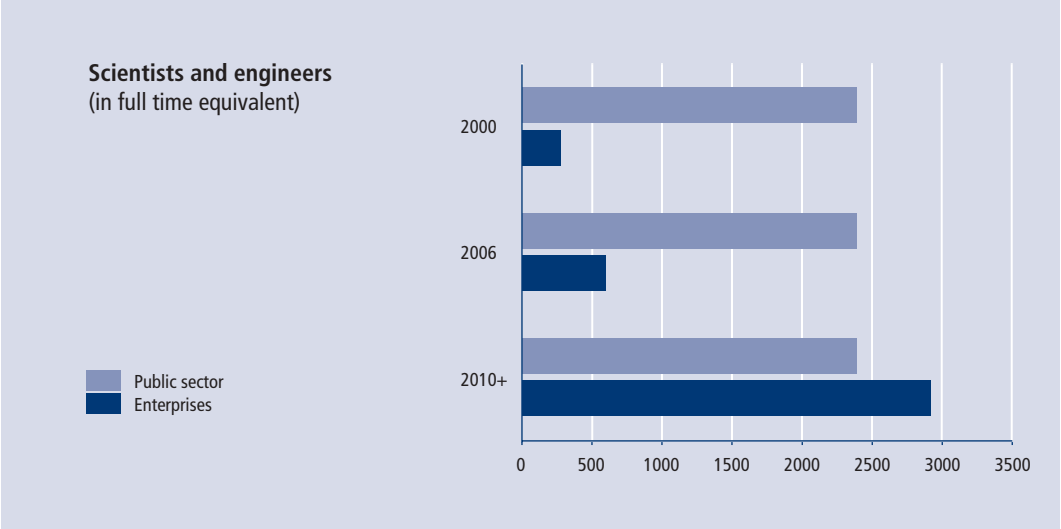
[113] Luke Georghiou, "Commentary on „Science and technology (foresight) in Europe: A prospective view"", Presentation at the JRC/IPTS Conference "The role of foresight in the selection of research policy priorities", Seville, May 2002.

[114] UNIDO Industrial Development Report 2002-2003.

[115] Peter F. Drucker, „The Discipline of Innovation", *Harvard Business Review*, November–December 1998.

Integration of research-intensive innovation and development activities into an enterprise's strategy and an increase in the respective investment therefore presupposes the existence of appropriately qualified scientists and/or engineers in this enterprise. Indeed, enterprises co-operate with each other and scientific research establishments in the specific areas of novel solutions in R&D projects. At the same time, international statistics show that the majority of corporate investment in R&D projects is spent by the private sector itself.[116]

Figure 21. **Investment in research and development activity, estimates of necessary labour**[117]



Sources: Statistical Office of Estonia 2002, Authors calculations.

In 1999, there were 4.3 scientists and engineers per 1,000 workers in Estonia, the corresponding figures of the developed countries (for example, Finland, Sweden, the USA) being nearly twice as big.[118] Guided by strategic objectives and the presumption that the number of scientists and engineers employed by the public sector (in full time equivalent) will not undergo substantial changes, we argue that if we want the objectives of the strategy *Knowledge-based Estonia* to materialise, the number of scientists and engineers in the private sector must double by the year 2006. At the same time, attaining the objective set by the Lisbon Strategy, according to which R&D investment should reach 3% of the GDP, would presume that the total number of scientists and engineers be doubled by the very rapid growth of the private sector[119] (Figure 21).

Provided that the system of graduate studies functions normally and considering the previous years' high admission indicators to doctoral study programmes, such a relatively rapid growth might even be achievable. However, worries are caused by today's overall tendency towards the number of scientists and engineers (Figure 30 in Annex) to decrease and the disproportionally small amount of completed degrees in comparison with the total number of doctoral students (Figure 32 in Annex). Taking the human resource to be the main driving force behind R&D activity, modernisation of education, including graduate studies, must be Estonia's ongoing priority in the coming years.

In connection with the human resources issue, it must also be noted that there have been a minimal number of foreign tenured professors in Estonia during the independence period. Estonia's economic openness must be accompanied by its openness to highly-qualified foreign labour.

116 *Main Science & Technology Indicators*, Volume 2001/1, OECD, Paris 2002.

117 The number of scientists and engineers in the year 2000 is given by the full time equivalent. Source: Statistical Office of Estonia.

118 The number of scientists and engineers in the private sector constitutes 55% of the European average total number of scientists and engineers. OECD 2002; Marek Tiits and Rein Kaarli, *Eesti teadus- ja arendustegevuse ülevaade 2001-2002* (Estonia's Review of Research and Development Activity 2001–2002), Tallinn 2001.

119 Calculations presume that the wages will be on the current level as a percentage of GDP and the private sector will employ 20% of the scientists' and engineers' labour in the year 2006 and 55% in the year 2010 instead of the present 11%.

4.4 Estonia's strategic choices

Discussing prerequisites of Estonia's rapid economic development in the future, we cannot avoid quoting Dr. Jüri Engelbrecht, President of the Estonian Academy of Sciences, who said the following about the formation of knowledge-based economies in the EU candidate countries: „In our opinion, everything starts from understanding. The politicians should understand the roles of research and technology, and the humanities in the future of their country, the research community should understand the social mission of research and the public should understand the importance of knowledge. This means that all actors have to reach an agreement both nationally and internationally."[120]

In order to escape from the status of a low-cost subcontractor, Estonia needs a comprehensive economic policy, which would be, on the one hand, aimed at increasing technological and organisational effectiveness by take-up of new know-how and technologies and, on the other, at a significant increase in the research and development activity corresponding to the needs of economic development. In-depth integration into international innovation, production and marketing networks is equally important.[121] Innovation policy must become central in the country's economic thought and its strategic national development plans.

As a matter of fact, Estonia has worked out measures for supporting research and innovation, ranging from the financing of specific research and development projects up to specialised programmes; however, their role is clearly too marginal to be able to influence the actual innovation processes of the economy. In reality, due to their small volume, the existing instruments of research and innovation policy can practically have no say in matters of economic development in its today's institutional framework.[122]

The European Federation of National Academies of Sciences and Humanities (ALLEA) has formulated recommendations which are entirely applicable to Estonia as well[123]:

– not only increasing the funding of research and development in general, but channelling it to the most prospective areas;
– not only introducing incentives for encouraging innovation per se, but creating foresight programmes, to develop the future vision with a broad consensus within the general public and formulating a national development plan guided by this;
– not only introducing incentives for stimulating young people in research and development, but estimating the long-term needs of manpower in academia and society;
– not only stimulating individual peer-reviewed research and development , but creating the centres of excellence in research, and ensuring their participation in respective international clusters;
– not only improving research infrastructures, but combining them with education and innovation.

[120] Jüri Engelbrecht, "From parts to whole", TRAMES special edition "Science policy (in Estonia), 1,7, 2003.

[121] *Teadus- ja Arendustegevus Eestis 2000-2001* (Research and Development Activities in Estonia 2000–2001), Research and Development Council, Tallinn 2001.

[122] The recent innovation survey of the Ministry of Economic Affairs and the Statistical Office shows that in 2000 Estonian companies invested ca 1.4% of their revenues or about 2 billion kroons into innovation. The major part of these investments consists of the export and application of new technology, which also entails a limited degree of development activity, modernisation of organisational processes, training, etc.

[123] Jüri Engelbrecht (ed), *National Strategies for Research in Smaller European Countries*, ALLEA and Estonian Academy of Sciences, Amsterdam, 2002; *European S&T Policy and the EU Enlargement.* Workshop of experts from the pre-accession CEC and the EUROPOLIS Project Group. Report, Simeon Anguelov and Pierre Lasserre, (eds.), UNESCO ROSTE, Venice, 2000.

[124] *World Employment Report 1998-1999*, ILO, Geneva 1999

[125] Carlota Perez, *Technological Revolutions and Financial Capital. The Dynamics of Bubbles and Golden Ages*, 2002, Cheltenham - Northampton, MA: Edward Elgar Publishers, 2002 or see in more detail Chapter 3.2.

Quality of foreign investment

As follows from the above analysis, considerable investments by Estonian entrepreneurs in high-tech research and development activity, or radical renewal of the existing technological base in the coming years are not likely.

On the one hand, the continuation of the habitual low-cost resource-based activity (wood processing and manufacture of furniture, leather and textile, food products) would provide a wider range of possibilities for development at a lower risk. On the other hand, the strategic capability and human resources of Estonian enterprises, as well as their capacity to penetrate the global market, are inadequate for such a research-intensive development activity. Even an arranged marriage of universities and entrepreneurs would not give much. The imitation of products and solutions created elsewhere may be useful for the participants in the process in acquiring new knowledge and skills, although in the end indigenous technological development will not provide for enterprises substantial advantages in direct market competition.

Therefore, after becoming a member of the European Union, regional co-operation (of the Baltic Sea countries) may become increasingly important for Estonia. In fact, this is of critical importance both in ensuring access to the global market and in attracting (higher quality) foreign direct investment.

In the coming years, the creation of novel research-intensive internationally competitive products in Estonia depends mainly on the interest of foreign capital (including multinational corporations) to transfer some sections of their development activity to Estonia. The ability of Estonia to attract, successfully absorb foreign direct investment and benefit from the concurrent transfer of technology to the economy (to domestic enterprises) as well as elaborate research-intensive products depends to a large extent on the country's technological capability, i.e. the skills and technical knowledge of the workforce.[124]

Recommendation: For the years to come, introduction and application of new technology will remain the main instruments for raising competitiveness of the Estonian economy. To enhance the effects of this process, Estonia will have to seek more purposefully for higher quality foreign direct investment into the supposedly faster-growing sectors of its economy. Special attention has to be paid to the creation of an adequate environment in Estonia that would suit to the R&D units of multinational corporations, and guaranteeing availability of qualified human resources.

Specialisation and economic clusters

No European country is able to support research and development simultaneously in all the areas. A small country like Estonia is even less capable for doing so. Therefore, it is becoming ever more important to identify those areas of specialisation that would support the development of culture, economy and society most, while maintaining, at the same time, the critical mass required for satisfying the local needs in other areas of research and development, and for building an increased awareness of world developments.

Estonia's ability to make its industrial structure substantially more knowledge-intensive during the present decade and to accelerate the country's economic development depends mainly on its ability to ensure the existence (or emergence) of top quality human resources necessary for the development of the ongoing and presumably consequent techno-economic paradigm (ICT, bio- and material technologies). The development of the economic sectors related to these key areas will most likely trigger the modernisation of all of the other sectors and growth in productivity of the economy.[125]

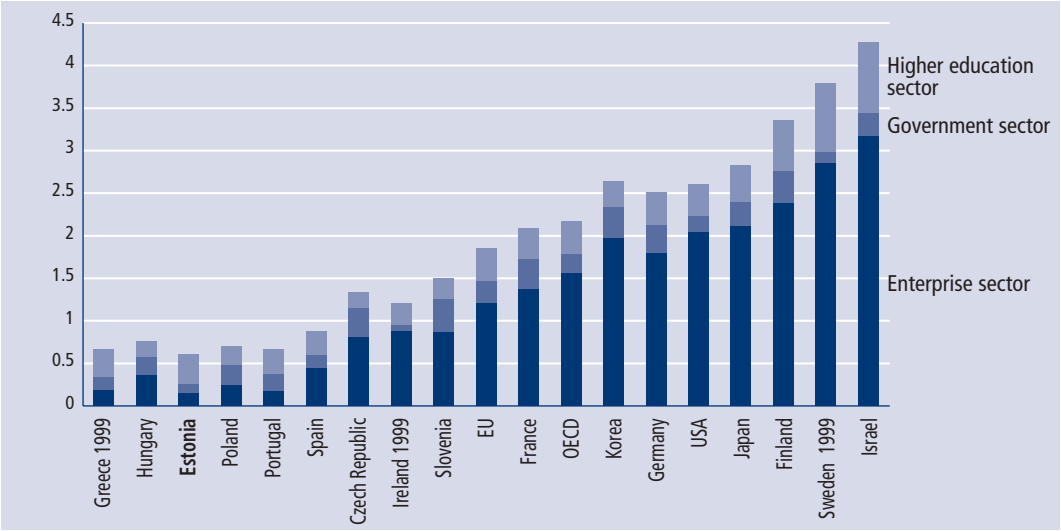
On the side of traditional industry, it is also important to monitor and support the eventual emergence of economic clusters related to the design and fashion industry on the basis of the leather, footwear, textile and apparel industries as well as the wood and furniture industry.

Recommendation: The birth of a truly high-tech indigenous industry in Estonia depends on the country's ability to develop and implement the industrial policy which is targeted to those areas that are essential for Estonia's future. We recommend that the Government should first and foremost prepare cluster programmes supporting the development of information, bio- and material technologies.

5. Annexes

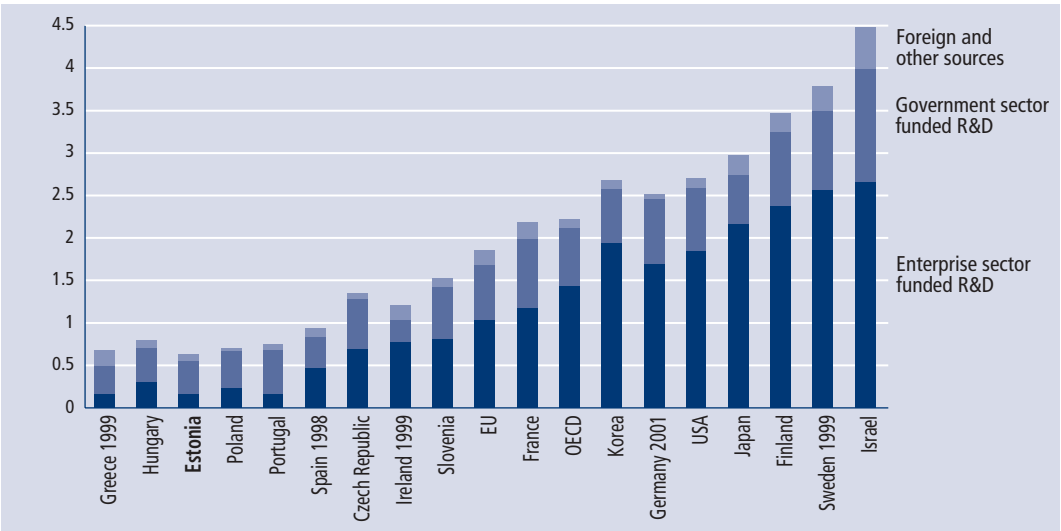
5.1 R&D financing and performance

Figure 22. **R&D expenditures by the performing sectors in some OECD countries and Estonia in 2000 (% of GDP)**



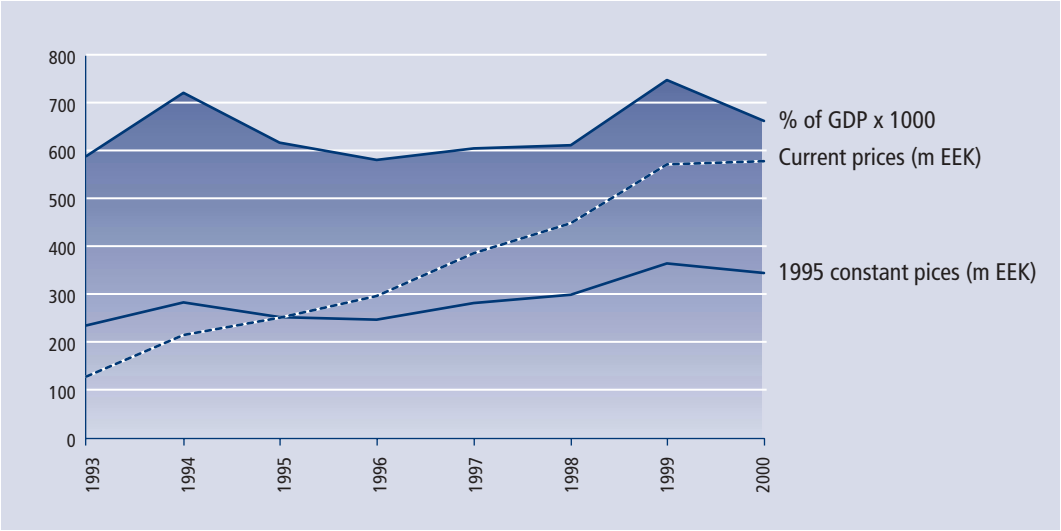
Sources: Main Science and Technology Indicators, 2002/1, OECD;
Yearbook Research and Development 2001, Statistical Office of Estonia.

Figure 23. **R&D financing by main sources of funds in some OECD countries and Estonia in 2000 (% of GDP)**



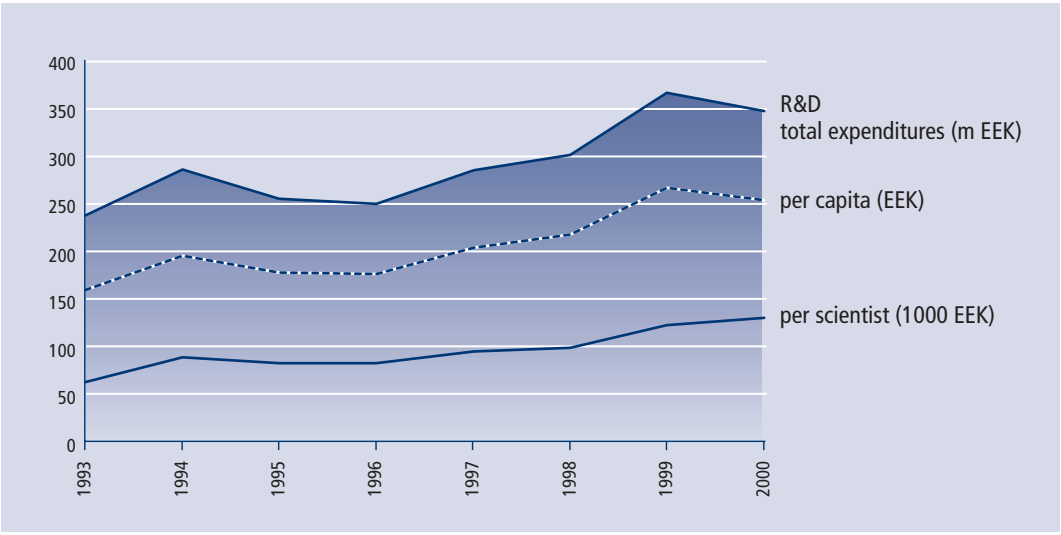
Sources: Main Science and Technology Indicators, 2002/1, OECD;
Yearbook Research and Development 2001, Statistical Office of Estonia,
Statistical Yearbook of Estonia 2002, Statistical Office of Estonia.

Figure 24. **Gross domestic expenditure on R&D (GERD) and its real growth 1993-2000**



Sources: Yearbook Science 1993 – 1999, Statistical Office of Estonia,
Yearbook Research and Development 2000 – 2001, Statistical Office of Estonia,
Statistical Yearbook of Estonia 2000 – 2002, Statistical Office of Estonia,
Estonian Statistical database of Statistical Office of Estonia at www.stat.ee.

Figure 25. **GERD per inhabitant and per researcher in constant 1995 prices**



Sources: Yearbook Science 1993 – 1999, Statistical Office of Estonia,
Yearbook Research and Development 2000 – 2001, Statistical Office of Estonia,
Statistical Yearbook of Estonia 2000 – 2002, Statistical Office of Estonia,
Statistical database of Statistical Office of Estonia at www.stat.ee

Table 10. **Gross domestic expenditure on R&D (GERD) in Estonia 1995–2000***

	Gross domestic expenditure on R&D (GERD)		Government expenditure on R&D (GOVERD)		Higher education expenditure on R&D (HERD)		Business enterprise sector expenditure on R&D (BERD)		
	m EEK	% GDP	m EEK	% of GERD	m EEK	% of GERD	m EEK	% of GERD	% GDP
1995	250.6	0.60	179.9	71.8	70.7	28.2			
1998	450.9	0.61	107.4	23.9	252.7	56.8	88.8	19.3	0.12
1999	572.8	0.76	141.6	24.7	291.7	50.9	137.0	23.9	0.18
2000	579.4	0.66	140.0	24.2	303.7	52.4	130.4	22.5	0.15
2001	763.5	0.79	107.6	14.1	385.8	50.5	256.6	33.6	0.26

*) Data on the business sector's R&D activities have been collected in Estonia since 1998

Sources: Yearbook Science 1993 – 1999, Statistical Office of Estonia,
Yearbook Research and Development 2000 – 2001, Statistical Office of Estonia,
Statistical Yearbook of Estonia 2000 – 2002, Statistical Office of Estonia.

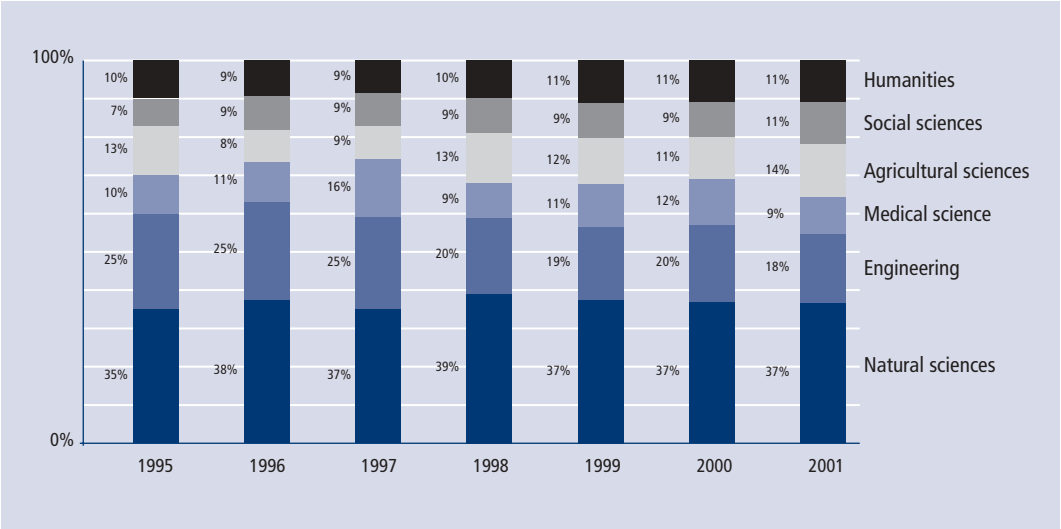
Table 11. **Financing of R&D expenditures in Estonia 1995–2000***

	GERD		Financed by government sector		Financed by business enterprise sector		Abroad	
	m EEK	% GDP	% GDP	% of GERD	% GDP	% of GERD	% GDP	% of GERD
1995	253.0	0.6	0.45	71.4	0.08	13.0	0.05	9.5
1996	305.7	0.6	0.41	70.7	0.06	10.1	0.07	10.8
1997	387.9	0.6	0.40	67.1	0.05	8.5	0.09	14.4
1998	450.9	0.61	0.39	63.0	0.15	23.8	0.04	6.7
1999	572.8	0.75	0.49	64.7	0.18	23.9	0.04	6.4
2000	579.4	0.66	0.40	59.1	0.16	24.1	0.09	12.6
2001	763.5	0.79	0.41	52.0	0.26	33.0	0.10	12.7

*) Data on the business sector's R&D activities have been collected in Estonia since 1998

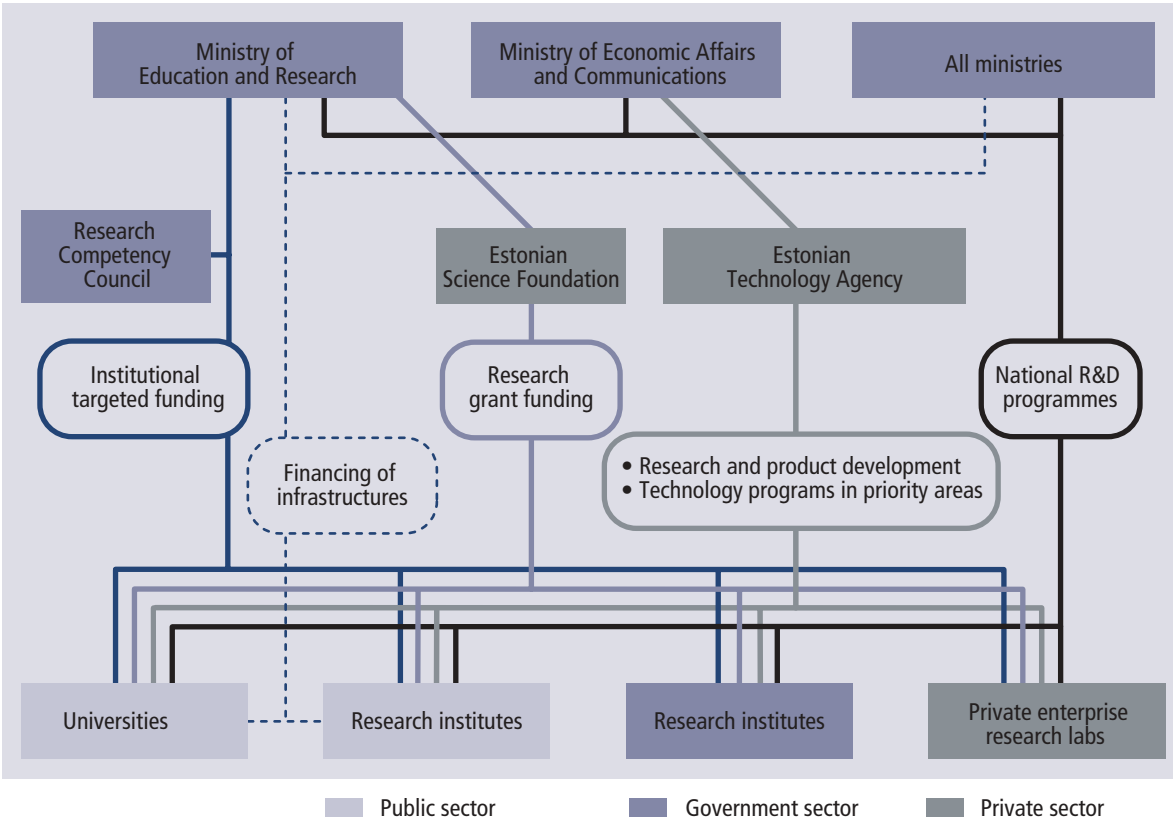
Sources: Yearbook Science 1993 – 1999, Statistical Office of Estonia,
Yearbook Research and Development 2000 – 2001, Statistical Office of Estonia,
Statistical Yearbook of Estonia 2000 – 2002, Statistical Office of Estonia.

Figure 26. **R&D expenditure in non-profit institutional sectors by field of science**



Sources: Yearbook Science 1993 – 1999, Statistical Office of Estonia;
Yearbook Research and Development 2000 – 2001, Statistical Office of Estonia

Figure 27. **State Budget Financing of Estonian Research & Development System**



* Target funding of research and development institutions on the basis of research topics is effected by the Ministry of Education according to the proposals of the Science Competence Council.

** The infrastructure costs of the state R&D institutions are covered from the budget of the Ministry under which the institution belongs

Table 12. **Financing of R&D from the State Budget (million EEK)**

	Target financing by research topics	Financing of infrastructure	Estonian Science Foundation research grants	Target financing. financing of infrastructures and research grants	All government sector financed R&D expenditures
1996	93.9	34.0	58.4	186.3	**224.2**
1997	102.3 [a]	39.5	68.3	210.1	**250.2**
1998	118.3	48.0 [b]	72.9	239.2	**284.0**
1999	161.4	58.3 [b]	76.6	296.3	**370.9**
2000	156.0	57.5 [b]	71.1	284.6	**342.7**
2001	176.0	61.2 [b]	71.1	304.3	**396.7**
2002	197.0	56.05	78.1	331.15	

Sources: General Government Budgets 1996 – 2002,
Yearbook Science 1995 – 1999, Statistical Office of Estonia,
Yearbook Research and Development 2000 - 2001, Statistical Office of Estonia
[a] including centres of strategic competence
[b] financing of the whole infrastructure

Table 13. **Estonian Science Foundation research grants and target financing by research topics in 2000–2002**

Teadussuund	Number of EstSF research grants	Average grant (000s EEK)	Number of EstSF research grants	Average grant (000s EEK)	Number of EstSF research grants	Average grant (000s EEK)
	2000		2001		2002	
Exact sciences	92	110.5	90	112.65	96	112.53
Chemistry and molecular biology	68	107.7	65	112.35	71	120.96
Bio- and geosciences	78	103.9	76	106.36	84	110.42
Engineering	134	88.6	139	84.24	146	88.58
Medical science	101	119.0	103	116.30	111	116.65
Agricultural sciences	80	97.7	71	109.85	66	117.27
Social sciences	99	70.4	88	75.59	94	78.10
Humanities	111	61.5	112	60.77	114	64.91
All fields	763	93.2	744	94.72	782	98.50
Funding of Estonian Science Foundation		**71 100**		**70 474**		**77 031**
Target Financing	269	580	253	623	266	673
+ topics of doctoral students			710		758	18.5

Sources: Ministry of Education, Estonian Science Foundation, Estonian Research Information System, http://www.eris.ee/.

Table 14. **Support from the Estonian Technology Agency 2001**

	Number of projects	Total cost of projects m EEK	Share of ESTAG m EEK	ESTAG funding per project m EEK
	32	146.8	47.6 incl loans: 18.5	1.5
incl. bio- and gene technologies and biomedicine	3	31.4	15.9	5.3
incl. product and material technologies	10	34.0	10.3	1.0
incl. information technology	4	5.9	1.5	0.4

Source: Estonian Technology Agency, 2002.

Table 15. **Financing products of ESTAG: loans and grants**

Purpose of financing	User of financed product	Product	Public funding up to:
Conducting feasibility studies	Enterprises and research institutions	Grant	75%
Conducting applied research	Enterprises	Loan	75%
		Grant	50%
	Research institutions	Grant	50% (up to 100%)
Promoting product development	Enterprises	Loan	75%
		Grant	25%

Source: Estonian Technology Agency, 2002.

5.2 Estonia's participation in the EU 5th Framework Programme (1998–2002)

Table 16. **Estonia's Participation in the EU 5th Framework programme**

	PROPOSALS SUBMITTED			PROJECTS FUNDED			
Programme	**Proposals**	**Participations**	incl. universities and research institutions	**Proposals**	**Participations**	incl. universities and research institutions	**Success rate (%)**
Quality of Life **(QoL)**	256	276	213	55	59	44	21.5
User-friendly information society **(IST)**	126	161	58	27	31	8	21.4
Competitive and sustainable growth **(GROWTH)**	27	29	14	9	10	4	33.3
Environment and sustainable development **(EESD)**	156	185	135	56	60	50	35.9
Energy and sustainable development **(EESD)**	59	68	36	19	25	9	32.2
Confirming the international role of Community research **(INCO 2)**	18	19	12	7	7	4	38.9
Promotion of innovation and encouragement of SME participation **(Innovation/SMEs)**	51	67	18	15	22	7	30.0
Improving the human potential **(IHP)**	115	137	103	28	31	22	24.3
Total	**808**	**942**	**589**	**216**	**245**	**147**	**26.7**

Source: Archimedes Foundation, October 2002.

Table 17. **EU contribution to Estonian partners in FP5 (Contracts signed until May 2002)**

Programme	m EEK	Share %
Quality of Life	46.69	29.40
User-friendly information society	15.85	9.98
Competitive and sustainable growth	1.31	0.82
Environment and sustainable development	30.58	19.25
Energy and sustainable development	6.71	4.22
International co-operation	25.47	16.04
Participation of SMEs	9.88	6.22
Improving the human potential	22.33	14.06
Total	**158.81**	**100 %**

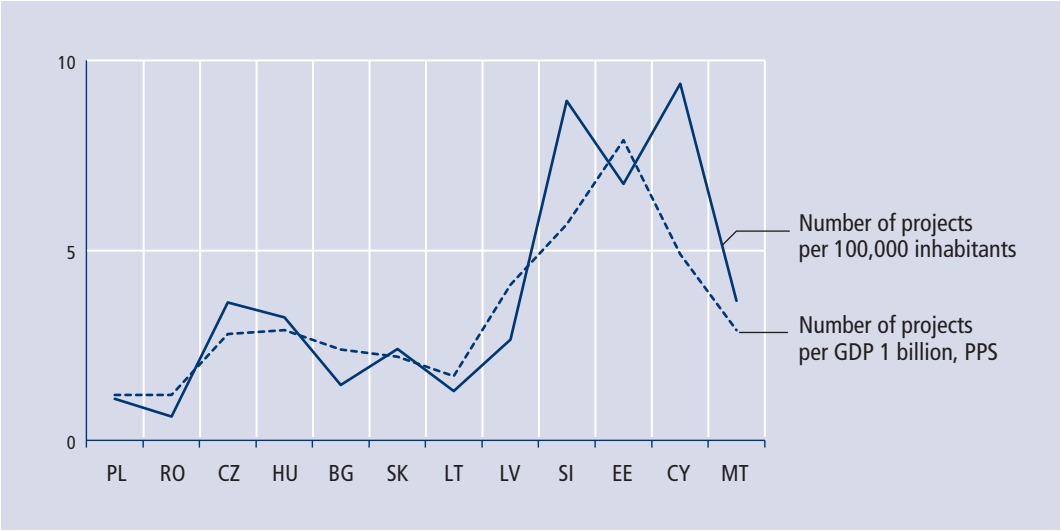
Source: European Commission 2002.

Table 18. **Geographical distribution of coordinators in projects with Estonian participation**

Coordinator country	Proposals with Estonian participation	Selected projects
Germany	123	26
UK	107	43
France	49	14
Finland	95	14
Sweden	70	15
Netherlands	67	19
Denmark	31	10
Estonia	**79**	**24**
Italy	32	10
Austria	40	7
Iceland	3	1
Belgium	16	8
Spain	21	5
Ireland	13	3
Poland	10	3
Latvia	6	3
Norway	13	6
Slovenia	2	2
Portugal	6	2
Luxemburg	2	
Hungary	3	
Lithuania	2	
Greece	10	
Chech Republic	2	
Israel	1	
Cyprus	2	
Switzerland	1	1
Total	**808**	**216**

Source: Archimedes Foundation, October 2002.

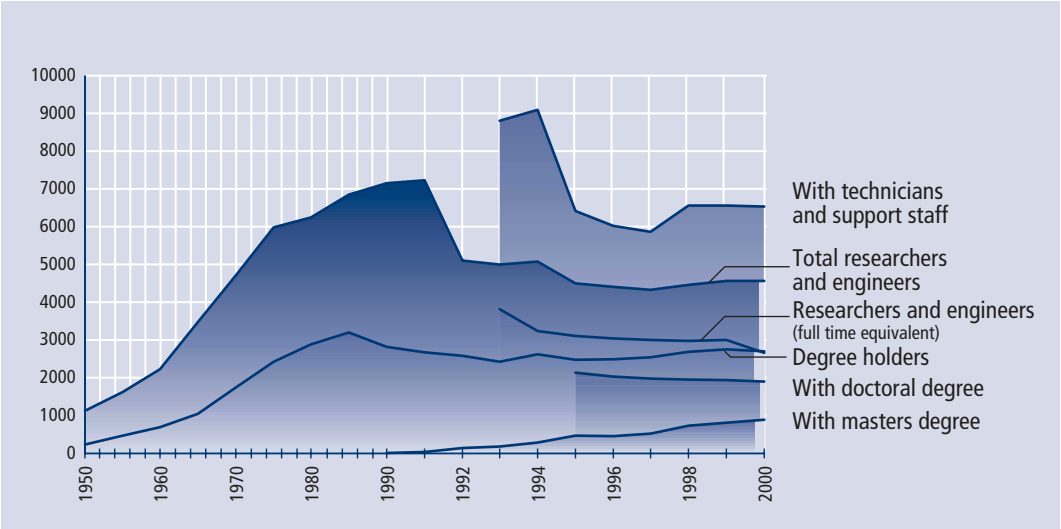
Figure 28. **Participation of the Candidate Countries in FP5, 1999–2001***



Sources: European Commission, October 2002,
GDP in Candidate Countries, Statistics in Focus, Theme 2 - 41/2002, Eurostat
The Candidate Countries in FP5 - Statistics, ISA - Information Service for Accession Countries, http://www.dlr.de/isa.
* Data of the European Commission and ISA take into account only projects already signed

5.3 Human resources in R&D

Figure 29. **Number of researchers by degree**



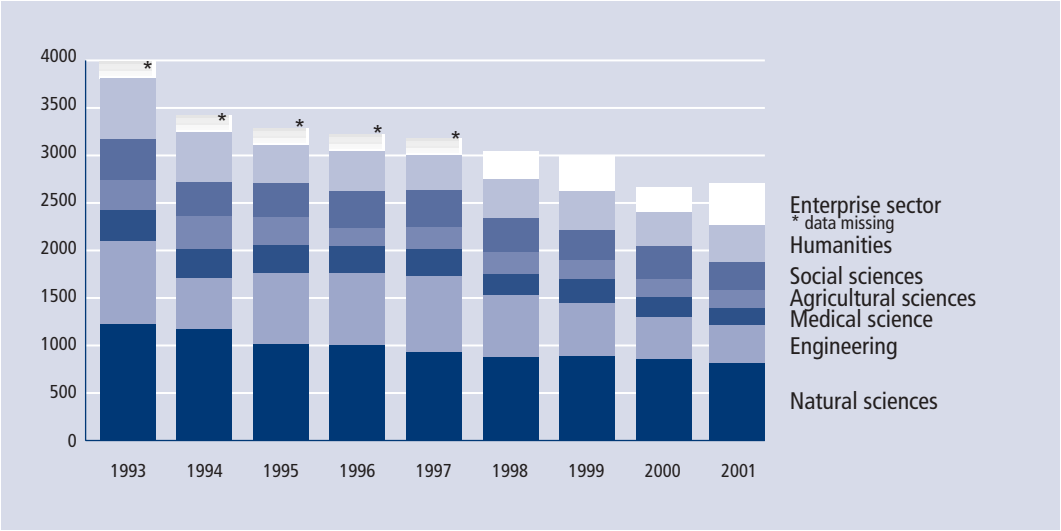
Sources: Yearbook Science 1995 – 1999, Statistical Office of Estonia,
Yearbook Research and Development 2000 – 2001, Statistical Office of Estonia.

Table 19. **Number of researchers by full time equivalent (FTE)**

	1997	1998	1999	2000	2001
Number of researchers (FTE)	3004	3045	3001	2666	2681
Number of researchers (persons)	4208	4485	4563	4570	4803
Number of researchers (FTE) per 1000 workforce	4.4	4.53	4.55	4.02	4.06

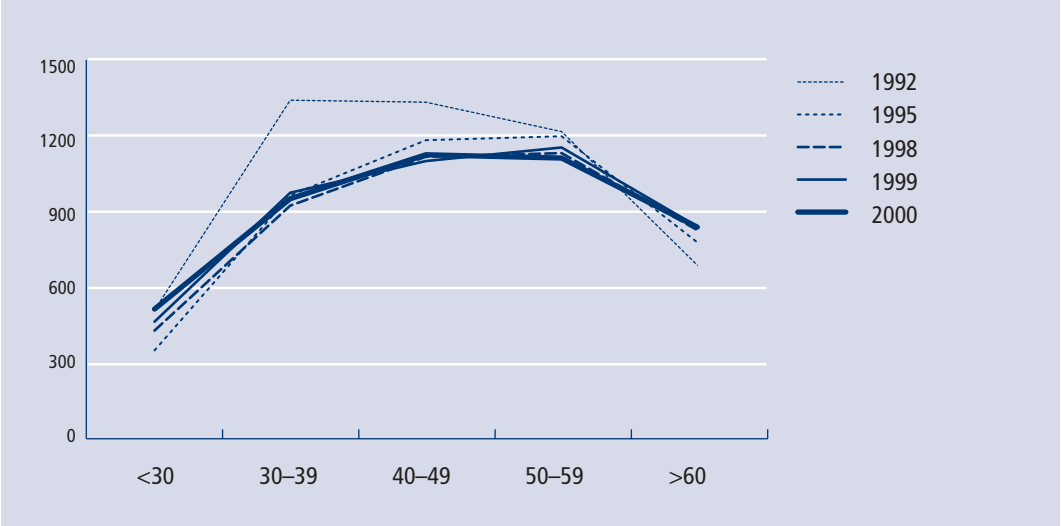
Sources: Yearbook Science 1993 – 1999, Statistical Office of Estonia,
Yearbook Research and Development 2000 – 2001, Statistical Office of Estonia,
Statistical Yearbook of Estonia 2000 – 2002, Statistical Office of Estonia.

Figure 30. **Researchers by field of science (FTE)**



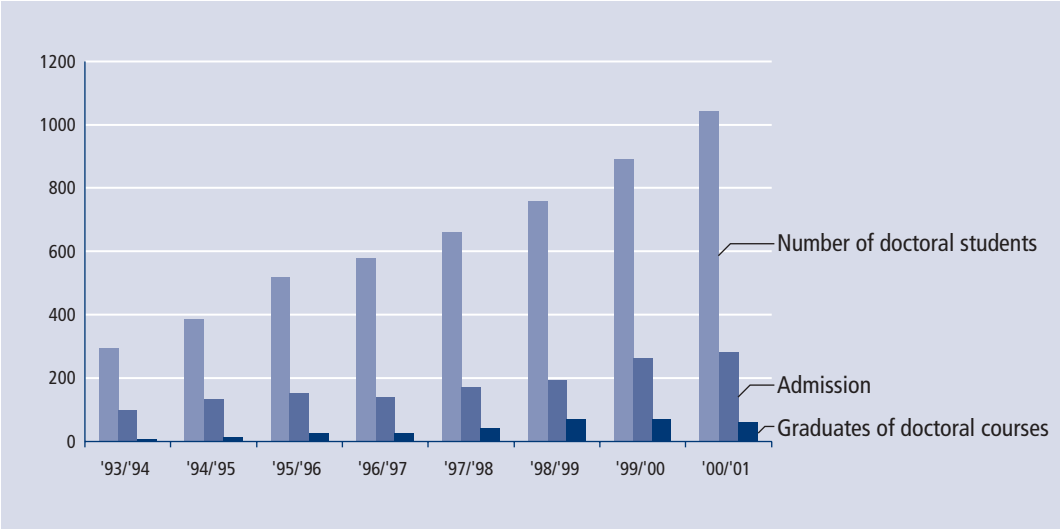
Sources: Yearbook Science 1993 – 1999, Statistical Office of Estonia,
Yearbook Research and Development 2000 – 2001, Statistical Office of Estonia.

Figure 31. **Distribution of researchers by age**



Sources: Yearbook Science 1993 – 1999, Statistical Office of Estonia,
Yearbook Research and Development 2000 – 2001, Statistical Office of Estonia.

Figure 32. **Doctoral studies**



Sources: Yearbook Science 1993 – 1999, Statistical Office of Estonia,
Yearbook Research and Development 2000 – 2001, Statistical Office of Estonia,
Statistical Yearbook of Estonia 2002, Statistical Office of Estonia.

Table 20. **Graduates from doctoral courses by field of study**

Field of study (A2)	ISCED97 code	1998/1999	1999/2000	2000/2001	Total 1994-2001
Arts	21				3
Humanities	22	5	10	14	42
Social and behavioural sciences	31	1	4	4	10
Journalism and information	32	1		1	2
Business and administration	34	1	3	5	9
Law	38			4	4
Life science	42	13	14	4	48
Physical science	44	13	16	15	64
Mathematics and statistics	46	5	1	2	8
Computer studies	48	5	5	1	11
Engineering and engineering trades	52	5	6	8	34
Manufacturing and processing	54				1
Architecture and building	58			1	2
Agriculture, forestry and fishery	62	6	5	2	32
Veterinary medicine	64	1	1		7
Health	72	13	7	1	44
Environmental protection	85	1			1
Total graduates		**70**	**72**	**62**	**324**

Sources: Statistical Office of Estonia 2002.

5.4 Patents and publications

Table 21. **Patenting in Estonia, 1994-2001**

	1994	1995	1996	1997	1998	1999	2000	2001
Filed patent applications	482	82	213	375	463	619	805	717
incl. from Estonia	16	16	12	15	20	13	12	19
Registered			22	108	82	103	84	257

Sources: Statistical Office of Estonia 2002, Estonian Patent Office.

Table 22. **Filed patent applications by field, 1997-2001* (share, %)**

	1997	1998	1999	2000	2001
Human necessities	29.8	22.4	21.4	22.8	27.2
Performing operations, transporting	10.4	12.0	7.9	5.5	7.1
Chemistry, metallurgy	44.2	36.9	30.3	31.1	39.8
Textiles, paper	0.2	0.8	1.1	0.2	0.4
Fixed constructions	4.2	3.8	3.3	2.3	3.9
Mechanical engineering, heating, weapons	3.2	3.4	2.5	1.6	2.8
Physics	5.6	4.1	7.1	8.0	5.0
Electricity	2.4	16.6	26.4	28.5	9.9
Applications not classified					3.9

Sources: Research and Development 2001, Statistical Office of Estonia; Estonian Patent Office.
* Data of the Estonian Patent Office by International Patent Classification (Parts A-H).

Table 23. **Patents in biotechnology and information and communication technology (1997-2001)**

	Filed patent applications	Incl. from Estonian applicants	Registered	Incl. to Estonian applicants
Biotechnology	89	4	5	0
Information and communication	399	2	81	

Source: Estonian Patent Library.

Table 24. **Patent applications to the EPO per 1 million of population, 2000**

Slovenia	Hungary	Czech Republic	Estonia	Latvia	Poland	Lithuania
20.7	16.0	12.1	7.3	2.5	2.3	1.1

Sources: Eurostat, EPO - European Patent Office;
E. Mardo, Research and Development 2000, Statistical Office of Estonia,
Tallinn 2001, pp. 22-25; Data of the Estonian Patent Office.

Table 25. **Publications by Estonian researchers in the ISI Science Citation Index databases**

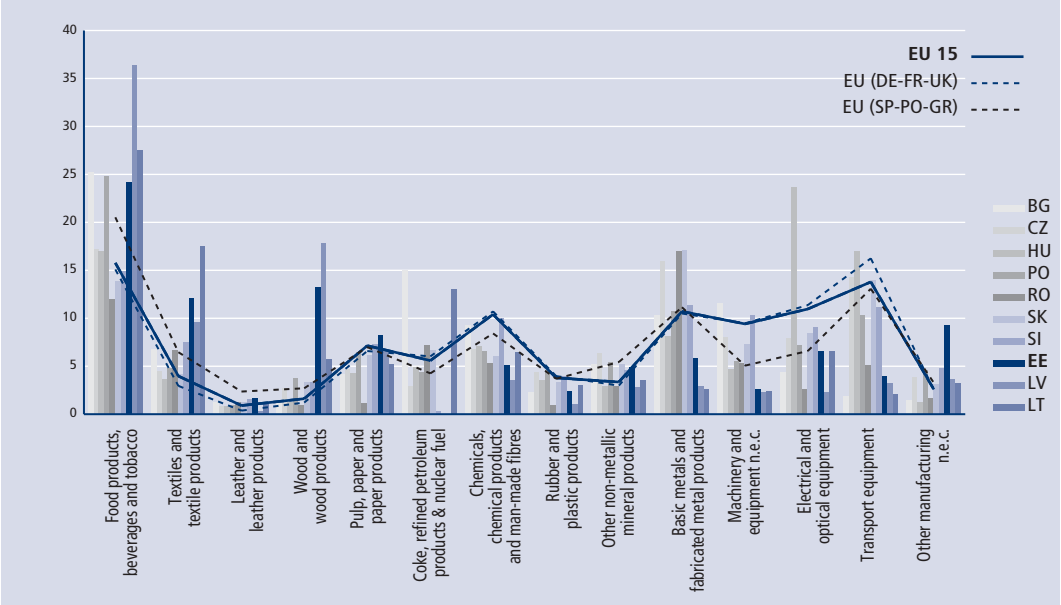
	1995	1996	1997	1998	1999	2000	2001
Total publications	382	439	512	585	623	635	648
Taking into account the share of authors from different countries*	217	219	222	254	261		

Sources: Institute for Scientific Information Science Citation Index,
Web of Science,
Science Citation Index Expanded (SCI-EXPANDED),
Social Sciences Citation Index (SSCI),
Arts & Humanities Citation Index (A&HCI),
Science & Engineering Indicators 2002.

*Article counts are based on fractional assignments; for example, an article with two authors from different countries is counted as one-half of an article for each country.

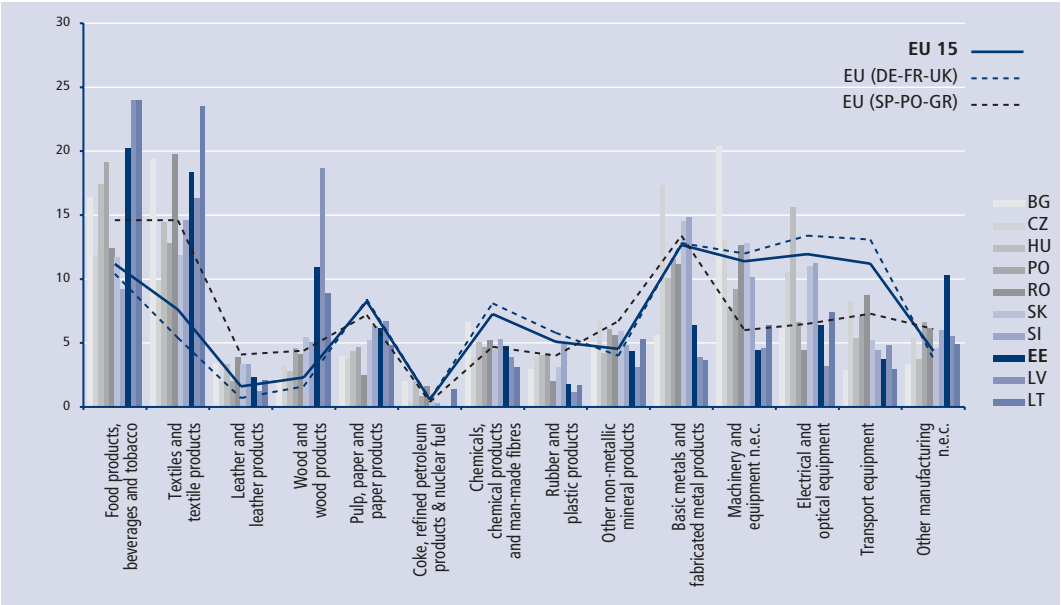
5.5 Industry and foreign investment

Figure 33. **Production structure in the manufacturing industry compared to the European Union, 1999**



Source: Peter Havlik, Restructuring of CEE Manufacturing Industry, Vienna Institute for International Economic Studies, August 2002, forthcoming.

Figure 34. **Employment structure in the manufacturing industry compared to the European Union, 1999**



Source: Peter Havlik, Restructuring of CEE Manufacturing Industry, Vienna Institute for International Economic Studies, August 2002, forthcoming.

Table 26. **The share of sales of foreign investment enterprises in 1993 and 1998**

		Czech Republic		**Estonia**		Hungary		Poland		Slovenia	
ISIC	Industry	1993	1998	**1995**	**1998**	1993	1998	1993	1998	1995	1998
15+16	Food, beverages & tobacco	13.9	24.9	**19.8**	**19.3**	48.1	55.7	12.5	37.6	7.2	10.2
17	Textiles	0.5	14.3	**40.5**	**70.5**	38.9	55.9	7.4	14.6	7.1	10.7
18	Wearing apparel & fur	1.6	6.9	**4.1**	**9.8**	39.6	47.2	23.3	40.1	2.0	1.1
19	Leather products	2.3	6.5	**0.0**	**45.5**	34.0	57.3	5.4	16.5	*	*
20	Wood products	4.7	20.8	**28.6**	**16.3**	31.8	45.5	12.9	43.6	2.5	2.6
21	Pulp & paper products	8.9	29.1	**0.0**	**77.5**	66.8	77.6	37.4	72.1	41.0	48.1
22	Printing & publishing	1.8	30.8	**0.0**	**19.7**	42.6	40.5	27.3	54.1	4.9	6.2
23	Petroleum & coke	0.0	0.0	**27.4**	**44.4**	2.1	100.0	0.0	0.4	*	*
24	Chemicals & chemical prod.	8.5	14.3	23	23	47.4	83.6	8.4	32.7	14.4	20.4
25	Rubber & plastics	21.8	45.8	**0.0**	**26.3**	58.1	51.7	17.4	56.7	13.6	20.1
26	Non-metallic mineral prod.	23.4	39.4	**56.8**	**61.0**	53.5	70.2	15.5	44.7	8.5	20.7
27	Basic metals	1.3	3.9	**0.0**	**10.6**	14.6	47.7	5.7	10.7	2.4	18.4
28	Fabricated metals	3.9	25.6	27	27	43.5	39.1	11.6	30.3	2.0	6.4
29	Machinery & equipment	2.0	12.3	**11.8**	**20.3**	32.9	52.6	8.1	18.5	20.4	26.1
30	Office machinery & computers	0.0	11.1	**0.0**	**42.7**	51.5	95.8	26.7	18.4	18.3	*
31	Electrical machinery	6.8	40.3	30	30	71.8	79.9	16.2	51.4	15.2	21.3
32	Radio, TV & communications equip.	2.5	41.8	30	30	53.5	82.8	31.7	81.8	39.6	42.5
33	Precision instruments	9.4	25.2	30	30	47.7	40.6	9.0	38.0	11.9	22.6
34	Motor vehicles	58.5	76.5	**0.0**	**13.7**	64.0	96.8	53.2	89.9	72.3	83.1
35	Other transport equipment	2.2	2.3	34	34	60.1	48.6	3.5	7.6	*	*
36	Furniture & misc. manufacturing	1.5	30.5	**0.0**	**18.9**	26.2	33.0	31.2	60.4	2.9	1.6
37	Recycling	0.0	40.3	36	36	27.9	31.6	22.4	20.6	0.0	0.0
D	Total Manufacturing	**11.5**	**27.2**	**20.1**	**28.2**	**41.3**	**70.0**	**13.7**	**40.0**	**17.6**	**24.4**

Sources: WIIW Database of Foreign Investment Enterprises, United Nations Economic Survey of Europe 2001, 1, Chapter 5, http://www.unece.org/ead/pub/surv_011.htm

Notes: *indicates sectors with less than 3 multinational firms but are included in total manufacturing.

Table 27. **Convergence of value added per employee between domestic and foreign firms**

		Ratio of labour productivity levels between domestic and foreign firms value added per employee									
		Czech Republic		**Estonia**		Hungary		Poland		Slovenia	
ISIC	Industry	1993	1998	**1995**	**1998**	1997	1998	1993	1998	1995	1998
15+16	Food, beverages & tobacco	0.70	0.52	**0.47**	**0.44**	0.42	0.49	0.85	0.45	0.64	0.71
17	Textiles	1.33	0.78	**0.49**	**1.05**	0.41	0.41	0.65	0.73	0.86	0.71
18	Wearing apparel & fur	1.05	1.00	**1.73**	**1.16**	0.59	0.56	0.81	0.58	1.49	0.72
19	Leather products	1.05	0.73	. . .	**0.98**	0.56	0.67	0.60	0.87		
20	Wood products	0.47	0.40	**-0.40**	**0.75**	0.33	0.35	0.96	0.42	1.08	0.53
21	Pulp & paper products	0.50	0.87	. . .	**0.59**	0.26	0.32	4.02	1.60	0.48	0.59
22	Printing & publishing	1.87	0.71	. . .	**1.05**	0.35	0.47	0.65	0.50	1.53	1.31
24	Chemicals & chemical prod.	0.49	0.57	**0.26**	**0.28**	0.33	0.33	0.62	0.70	0.89	1.05
25	Rubber & plastics	0.59	0.45	. . .	**0.31**	0.46	0.56	0.48	0.55	0.96	1.10
26	Non-metallic mineral prod.	0.62	0.42	**0.73**	**0.40**	0.36	0.41	0.44	0.49	0.47	0.49
27	Basic metals	0.75	0.72	. . .	**1.07**	0.48	0.70	0.99	0.63	0.99	0.70
28	Fabricated metals	0.86	0.70	. . .	27	0.53	0.64	0.56	0.43	0.76	0.93
29	Machinery & equipment	1.40	0.68	**0.51**	**0.36**	0.59	0.77	0.41	0.56	0.57	0.72
30	Office machinery & computers	.		. . .	**1.03**	0.08	0.12	0.12	1.64	0.52	
31	Electrical machinery	1.15	0.72	. . .	30	0.41	0.48	0.81	0.69	0.67	0.77
32	Radio, TV & communications equip.	0.10	0.54	. . .	30	0.48	0.44	0.59	0.19	0.40	0.58
33	Precision instruments	0.85	0.84	. . .	30	0.61	0.68	0.50	0.29	2.32	1.02
34	Motor vehicles	0.81	0.38	. . .	**1.45**	0.22	0.20	2.84	0.19	0.57	0.47
35	Other transport equipment	2.93	1.21	. . .	34	0.50	0.92	0.66	1.05	*	*
36	Furniture & misc. manufacturing	1.18	0.68	. . .	**0.59**	0.43	0.63	0.76	0.54	0.97	1.63
D	Total Manufacturing	**0.66**	**0.53**	**0.56**	**0.70**	**0.35**	**0.39**	**0.84**	**0.47**	**0.66**	**0.70**

Sources: WIIW Database of Foreign Investment Enterprises, United Nations Economic Survey of Europe 2001, 1, Chapter 5, http://www.unece.org/ead/pub/surv_011.htm

Notes: *indicates sectors with less than 3 multinational firms but are included in total manufacturing.

Table 28. **FDI support measures in different CEE countries**

	Hungary	Czech Republic	Poland	Slovenia
TAXES	•18% corporate tax •20% dividend tax	•31% corporate tax	•32% corporate tax	•25% corporate tax •1.5% withheld tax
INCENTIVES	•Corporate tax relief for up to 10 years for investment of at least 40 million USD and more than 500 employees. •Corporate tax relief for up to 5-10 years for investment in production, hotels	•Corporate tax relief for up to 10 years •Criteria - investment of 10 million USD, at least 50% goes to the manufacturing sector, 40% of the investment goes to new machinery	•Tax deduction up to 30% of investment amount from the tax base: conditions e.g. revenue from export is over 50%, buying patents, ISO 9000, pharmaceutical industry	•Job creation support scheme •Possible negotiation about government's financial support
SPECIAL INITIATIVES	•For regions with unemployment over15% •Corporate tax relief for up to 5 years for investment in production •Establishment of innovation centres - up to 30%, industrial parks: - up to 50% of recognized costs •Investments connected with local business development up to 40% of recognized costs	•Location in a customs-free zone •Job-creation grants (up to 3,000 USD per each new job) •Training grants (up to 50% of the costs) •Provision of low-cost building land and / or infrastructure (government assistance up to 60% of preparing land and infrastructure)	•Full tax allowances in selected regions for investment projects of at least 0.4 million EUR	•10% corporate tax in free zones (also some other benefits - e.g. another reduction of the tax base by investment, for job creation or training)
CUSTOMS REGIME, FREE ZONES	•Customs-free zone status for export-oriented companies	•Duty-free imports of new machinery related to projects exceeding 10 million CZK •Customs clearance - drawback system	•Duty-free import of machinery under OECD list 84 and 85 •Duty-free import of the fixed assets as a contribution to the share capital •Duty-free special zones	•Duty-free import of new machinery under OECD list 84 and 85 •Customs-free trade zones

Source: Gábor Hunya, International Competitiveness Impacts of FDI in CEEC, Background Paper for Special Session III on FDI and the restructuring of transition and emerging economies, UN Economic Commission for Europe, December 2000, p.15.